University of Alberta

Self Determination Theory and Exercise In Colorectal Cancer Survivors

by

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ABSTRACT

Objectives: The primary purpose of the present study was to evaluate Self-Determination Theory (SDT) as a framework for understanding exercise motivation and behavior in colorectal cancer survivors (CRCs).

Methods: Participants were 414 CRCs who completed a mailed survey that assessed self-reported exercise, quality of life (QoL), behavioral regulation for exercise, psychological needs satisfaction in exercise (PNSE) for competence, relatedness, and autonomy as well as perceived autonomy support (PAS), and vitality.

Results: Hierarchical regression analysis (HRA) indicated that identified regulation ($\beta=.26$, $p<.01$) and PNSE for relatedness ($\beta=.11$, $p<.05$) were the only significant unique contributors to variance in exercise behavior. HRA indicated that 24% of the variance in QoL was explained by SDT; competence made the most significant contribution ($\beta= .30$, $p<.001$), followed with autonomy ($\beta= .12$, $p<.05$), and external ($\beta= -.10$, $p<.05$).

Conclusions: This study extends the exercise and SDT literature into the cancer survivor population, and is the premiere application of exercise in cancer survivors for SDT. Overall, support for the applicability of SDT within this population was found.

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CHAPTER ONE

Statement of Problem

There will be an estimated 19, 200 new cases of colorectal cancer diagnosed in Canada this year[1]. Current trends indicate a slight increase in the incidence of colorectal cancer since 1997, however mortality has continued to decline for both males and females[1]. While colorectal cancer boasts a high five-year relative survival rate, many survivors must cope with the long-term physical and psychological effects of the often toxic treatment regimes. Previous research in colorectal cancer survivors (CRCs) has shown some benefits of exercise as a management strategy to help ameliorate the physical, functional, and emotional concerns that arise during recovery from this cancer and its therapy. Unfortunately, according to a recent study, only about 15% of cancer survivors are meeting the general public health exercise guideline of the American College of Sports Medicine[2]. This poor participation rate illustrates the need for theoretically driven research to further understand exercise motivation and adherence in this population.

Self-Determination Theory (SDT; [3]) has been used to examine the determinants of exercise behavior and motivation in other populations. This theory postulates that motivation for performing behaviors lies along a continuum between internally and externally regulated behaviors. SDT maintains that when basic psychological needs for competence, autonomy, and relatedness to others are met, individuals will become more self-determined in their behavioral regulation[4]. Self-determined behavior is associated with intrinsic motivation, greater psychological well being, and consequently, greater adherence to the given behavior [5]. While this theory has been successfully applied in medical settings, and to the exercise domain, it has not been used in the area of exercise and cancer. Within this study, SDT was tested in a sample of CRCs in an attempt to better understand the determinants of exercise in this population.

Disease and Epidemiology

Colorectal cancer begins as the uncontrolled growth of cells that line the innermost surface of the large intestine and rectum. It is defined as a malignancy, or uncontrolled abnormal growth of cells, that arises from the lining of either the colon or the rectum[6]. Colorectal cancer is considered a major public health issue in western countries [7]. There will be an estimated 19 200 (10 400 men, 8800 women) new cases of colorectal cancer in Canada this year, 1480 of which will occur in Alberta (820 men, and 660 women)[1]. This represents 12.4% of all new cancer diagnoses, and is one of the four most common sites of cancer[1]. The five year relative survival rate in Alberta is 55% for women and 54% for men [8]. Overall, early localized stages of colorectal cancer have a 86.6% five-year survival rate, after spread to adjacent organs or lymph nodes this rate drops to 66%, and after spread to distant sites this rate drops to 9.2%[9].

Colorectal cancer results from a series of genetic alterations leading to progressive and irreversible loss of normal control of cell growth and differentiation [7]. Most colorectal malignancies develop from a pre-existing adenoma, a category of polyp or well demarcated lump of dysplastic epithelium, that can be found in all segments of the large bowel. While such adenomas represent the natural precursor for cancer, some polyps will remain dormant[7]. The composition of the large bowel is characterized by glands known as crypts that are made up of columnar and mucinous cells that tend to be

40-60 cells deep [7]. Under healthy conditions the reproductive zone is limited to the lower portions of the crypts: cells will migrate to the upper mucosal surface and are then removed. In the case of colorectal tumorigenesis, the colonic epithelial cells are unable to contain DNA synthesis during movement from the base to the surface of the crypt. These epithelial cells develop an augmented ability to reproduce causing the proliferative zone to expand. Cells are then distributed through the whole length of the gland [7]. Therefore, carcinoma begins as a generalized disorder of the cell replication and differentiation that accompanies development of a lesion [7]

Colorectal carcinoma has a tendency for local invasion and lymphatic, hematogenous, transperitoneal and perineural spread [7]. By the time of diagnosis about 25% of colon cancers will have extended through the bowel wall. Similarly, at the time of diagnosis, rectal cancer will have spread through the wall in 50-70% of cases and metastasized to lymph nodes in 50-60% of cases. The most common site of metastatic spread is the liver [7]. The lung is the most frequently affected extra-abdominal organ. Other common sites of metastases include the peritoneum and abdominopelvic lymph nodes. Less common sites include the bones, kidneys, adrenal glands, and cerebellum [7]

The risk of developing colorectal cancer begins to increase at age 40, with the mean age of onset at 60-65 years [7]. Colon carcinomas constitute approximately 70% of all cancers in the large bowel. The three different types of colorectal malignancies are: a) cancer of the right colon, b) cancer of the left colon, and c) cancer of the rectum [7]. Five year survival rates have improved for colorectal cancer in recent years, due mainly to more surgical resections, modern anesthetic techniques, and improvements in supportive care as well as more accurate screening and diagnostic procedures and adjuvant therapies[7]. This has led to a relative survival rate for colorectal cancer of about 55%, as outlined previously [8]. Age-adjusted incidence and mortality rates for colorectal cancer continue to decrease although the reasons are not completely understood. However, casual screening is prevalent in Canada and may have contributed to the reduction in mortality rates[8].

Several lifestyle factors have been associated with risk and development of colorectal cancer. There is convincing evidence that physical activity has a protective effect given that research has demonstrated an inverse association between physical activity and colon cancer [10]. Obese individuals, smokers, or those who ingest excessive levels of alcohol are at an increased risk of colorectal cancer [10]. It is plausible that physical activity could play a role in reducing recurrence rates in CRCs similar to its role in reducing incidence rates [11].

Treatment

Surgery

The primary therapy for colorectal cancer is surgical removal of the bowel segment containing the tumor, the adjacent mesentery (the membranous fold attaching the small intestine to the dorsal body wall), and the regional lymph nodes [7]. About 75% of patients with colorectal carcinoma will present at a stage when the entire gross carcinoma can be surgically resected. Despite this, almost half of all colorectal cancer patients die of metastatic disease, mainly due to residual micrometastatic disease not apparent at the time of surgery [7].

Adjuvant Therapies

The use of adjuvant therapy to remove any microscopic disease outside the area of resection, which will ultimately develop into recurrent disease, is an attempt to improve the cure rate [12]. As no technology exists to identify patients who harbor micrometastatic disease, the stage of tumor is used as an important prognostic factor for determining which patients require adjuvant therapy [12]. Stage I tumors do not usually require additional postoperative therapy. However, in stage II and III rectal cancer, as well as stage III colon cancer, the risk of residual or micrometastatic disease is substantially higher and adjuvant therapy is standard [12].

Systemic chemotherapy is the principal adjuvant therapy for colon cancer, with a primary goal of decreasing the risk of distant metastatises[12]. At present, definitive evidence regarding the efficacy of chemotherapy on stage II colon cancer patients is lacking and controversial [12, 63]. Currently, adjuvant treatment for stage II colon cancer is not standard of care. Stage II colon cancer patients who have other clinical or histopathological high-risk features are considered for discussion of the potential role of 5FU/leucovorin adjuvant chemotherapy. Patients with stage III colon cancer typically receive postoperative adjuvant chemotherapy with fluorourcial (5FU)/leucovorin for 6-months [63]. This has been reported to increase overall survival to 65-66% for such patients [12]. It has been demonstrated that such treatments decrease the odds of dying of the disease by 25-50%[10].

The primary focus of adjuvant therapy in rectal cancer is to optimize both overall survival and local recurrence-free survival [12]. The standard of care may involve preoperative radiation therapy with or without chemotherapy, or postoperative combined chemo-radiation therapy[12]. Radiation therapy decreases local recurrence by half; addition of 5-FU based chemotherapy further decreases local recurrence to approximately 10%, and increases five-year survival by about 10-15% over surgery [12]. There is still debate about whether radiation should occur prior to or following surgical resection [10, 12]. Overall, it depends on the type of surgery that can be performed, the possibility of sphincter preservation and/or need to downstage the tumour, the needs and presenting symptoms of the patient, as well as the preference of the treating surgeon and oncologist [10, 12].

In stage I and II rectal cancer there are several options for standard treatment regimens. Following surgery, typically treatment involves postoperative chemotherapy and radiation therapy[63]. Surgery combined with adjuvant chemotherapy and postoperative radiation therapy is also a standard treatment option. In situations where the bladder, uterus, vagina, or prostate is involved, treatment typically entails adjuvant chemotherapy and postoperative radiation therapy[63]. When the goal of treatment is to preserve sphincter function, the treatment protocol is preoperative radiation with or without chemotherapy followed by surgery with postoperative adjuvant chemotherapy[63].

Short and Long term effects of treatment

There are a multitude of short term effects associated with the treatment of colorectal cancer[6, 7]. Abdominal pain or cramping is common following surgery, chemotherapy or radiation therapy. Appetite or taste changes often occur after chemotherapy and radiotherapy, as well as, bowel obstruction, low blood counts with risk of fever and infection. Some patients notice side effects such as chest pain, cognitive changes, constipation, dehydration, diarrhea, fever, hair loss, and headache. Other medical issues such as infection or heart damage are possible following chemotherapy. Reports of fatigue are now identified as one of the most debilitating long-term effects of cancer treatment [6]. However, the exact causes of such fatigue are unknown. It is generally believed that levels of fatigue increase as duration of intensity of treatment increases[6]. Additional causes of fatigue are also hypothesized to include difficulty breathing, chemotherapy-induced damage to the heart, and worry.

Many long term effects from the treatment of colorectal cancer can occur within weeks of treatment to months or years following treatment[6]. Some such effects are consequences and complications of surgery, such as the need for a permanent ostomy, development of scar tissues immobilizing or constricting bowels, damage to nerves causing pain and dysfunction, urinary or fecal incontinence, difficult bowel movements, abdominal pain and cramping, fistulae, and hernia. Psychological difficulties such as depression and anxiety are recognized as frequent long-term issues related to cancer stress. However, there are also a multitude of specific later effects resulting from the combination of surgery and adjuvant treatments[6]. In the case of colorectal cancer, 5-FU is known to cause cardiovascular damage in some people when high doses are used [6]. It is more rarely reported in the doses used for treating colorectal cancer.

Importantly, one of the most serious risks of the cancer itself is that of developing a second cancer. It is believed that the analogous environmental or genetic abnormality that elicited the first cancer can cause a second primary cancer that is distinct from a recurrence or metastasis of the original cancer [10]. CRCs are also more likely than the general population to develop second primary types of cancer subsequent to the colon [6].

Such tumor sites include: breast, prostate, endometrium, uterine, kidney, bladder and ovarian cancers [6].

Colorectal cancer and quality of life

The term quality of life (QoL) has surfaced in cancer research to summarize the broad-based assessment of the combined impact of the disease and its treatment and the trade-off between the two, and is commonly used as a clinical trial end point[13]. Despite the obvious issues of survivorship, research has shown that CRCs display a relatively high QoL [14]. This research has also outlined that the impact of colorectal carcinoma on health related QoL appears to be the greatest in the first 2-3 years following diagnosis [14, 15]. Functional and social well-being aspects of QoL were impacted for this group, and did not appear to change with time from diagnosis [14]. Courneya and colleagues [16, 17] found similar results for other elements of QoL, reporting that functional QoL tends to be the most important dimension of QoL in this group.

Current Supportive Interventions for Colorectal Cancer Survivors

There are limited interventions targeted at improving QoL for CRCs. Cheung et al [18], conducted a randomized controlled trial to test the effectiveness of progressive muscle relaxation training (PMRT) on anxiety and QoL after stoma surgery in colorectal cancer patients. They found that the use of PMRT significantly decreased state anxiety and improved general QoL. However, the authors note that PMRT is unlikely to reverse the functional disability caused by the surgery or the disease process itself. While many psychosocial interventions have been deemed effective in cancer populations for influencing some aspects of QoL, they are often inadequate at increasing the physical and functional parameters of QoL [19].

Exercise in Cancer Survivors

One supportive care strategy that has been implemented to help ameliorate physical and functional declines during and following cancer treatment is physical exercise [20]. Here, physical exercise is defined as a form of leisure–time physical activity that is performed on a repeated basis over an extended period of time with the intention of improving fitness or health [21]. Several studies have investigated the potential benefits of regular exercise following cancer treatment in different cancer survivor groups [16, 17, 22-24]. Potential benefits of exercise for cancer survivors include improvements in muscular strength, exercise capacity, flexibility, immune parameters, satisfaction with life, self esteem, mood, fatigue, anxiety, depression, physical well-being, and overall QoL[25-27].

Exercise, Colorectal Cancer and QoL

Several lifestyle factors have been associated with risk and development of colorectal cancer. There is convincing evidence that physical activity has a protective effect given that research has demonstrated an inverse association between physical activity and colon cancer[10]. Therefore, it is reasonable to speculate that exercise following colorectal cancer could reduce the risk of recurrence in this population[11].

Research investigating the effects of exercise in colorectal cancer patients is limited to three studies: one retrospective[16], one prospective [17], and one randomized trial [28]. All of these studies employed the use of self-reports of exercise, measures of satisfaction with life, QoL, as well as other outcomes [16, 17, 28]. One important finding was that of the six dimensions of QoL measured, CRCs scored the lowest on the functional dimension of QoL. Moreover, functional QoL had the strongest relationship with satisfaction with life indicating the importance of functional ability in this population[16]. Secondly, Courneya and associates found that those individuals who were active prediagnosis but failed to be active during treatment and post treatment reported the lowest QoL [16]. A positive correlation between the change scores indicated that decreases in exercise were associated with decreases in QoL, and increases in exercise were associated with increases in QoL[17, 28]).

The only randomized controlled trial to date was the Colorectal Cancer and Home-Based Physical Exercise (CAN-HOPE) trial. The CAN-HOPE trial was designed to examine the effects of a home-based exercise program on QoL and physical fitness in postsurgical CRCs[29]. About 55% of participants were receiving adjuvant therapy at the time of the exercise intervention. One hundred and two CRCs were randomly assigned in a 2:1 ratio to an exercise (n=69) or control (n=33) group. The exercise group was asked to exercise independently 3-5 times each week for 16 weeks at a moderate intensity for a minimum of 20-30 minutes each time. The control group was asked not to begin a structured exercise program. Outcomes were assessed at baseline and postintervention. Physical fitness was assessed by a submaximal treadmill test, a sit-and-reach-test, and a skinfold test. QoL was assessed by the Functional Assessment of Cancer Therapy-Colorectal (FACT-C) scale[13].

Overall, 91% of participants completed the trial and 76% adhered in the exercise group. However, 52% of the control group reported regular exercise. Not surprisingly, no intention-to-treat effects were found in the outcomes paper [29]. In an “on treatment” ancillary analysis, however, it was found that participants who increased their fitness over the course of the intervention had more favorable changes in anxiety, depression, overall QoL, and satisfaction with life than participants who decreased their fitness over the course of the intervention. The CAN-HOPE trial was the first to test an exercise intervention in CRCs. Notwithstanding the major exercise adherence and contamination problems, the findings suggest that improving fitness in this group of survivors may be associated with improvements in psychosocial functioning and overall QoL.

Exercise Motivation in Cancer Survivors

Research has shown that despite the potential benefits of physical activity, only a small percentage of cancer survivors are physically active. During formal exercise trials cancer patients and survivors maintain adherence rates that vary from 71.5% to 98.4%; demonstrating the ability of such participants to successfully complete an exercise program. However, these studies have small sample sizes, used supervised exercise regimens, and have little generalizibility to exercise adherence in the population of cancer survivors at large. There is little evidence to suggest that cancer patients are able to maintain such adherence rates without the close supervision of a clinical trial. Several studies have used retrospective[30, 31], prospective[32] methodologies to study the natural effect of cancer on exercise participation. These studies report that the percentage of cancer survivors who exercise regularly is as low as 16 -20%[31, 33] with a general consensus that survivors of cancer are not exercising at levels that can yield health benefits [2, 32]. Several studies also reported the cancer experience had a negative overall effect on exercise participation [30, 34].

In colorectal cancer specifically, several studies have examined changes to exercise behavior and adherence rates during the cancer experience. In an early study, Courneya and colleagues retrospectively examined the exercise patterns of 130 CRCs[16]. It was found that 61.5% were active at prediagnosis, 36.9% were active during treatment, and 53.1% were active posttreatment. The definition of active used by Courneya, however, was less than the currently recommended guidelines so these numbers are likely an overestimate of the number of CRC survivors who are active. Nevertheless, four main patterns of exercise behavior over the three time points were found: a) 30 % of participants were maintainers, those who were active at all three time points, b) 16% were temporary relapsers, those who were active prediagnosis, inactive during treatment, and active posttreatment, c) 14% were permanent relapsers, those who were active prediagnosis, inactive during treatment, and inactive posttreatment, and d) 30% were nonexercises, those who were inactive at all three time points. Active treatment had a significant negative effect on exercise participation level that was not completely recovered posttreatment. In fact, within 1-4 years of diagnosis, individuals treated for colorectal cancer had not fully returned to their prediagnosis level of exercise[16]. Corroborating results were reported in a prospective study of 53 postsurgical CRCs who were followed over four months [17]. At baseline, about 2 months post surgery, survivors engaged in an average of about 2.64 sessions/per week of mild exercise, 1.53 sessions/week of moderate exercise, and 0.53 sessions of strenuous exercise. The only significant changes in exercise behavior after four months, was the frequency of strenuous exercise, which declined minimally to 0.49 sessions/week[17].

Overall, this research reports discouraging rates of exercise among cancer patients, and outlines the negative effect that the cancer experience has on exercise behaviors. This further demonstrates the need for theoretically driven research to examine the determinants and motivations underlying exercise in this population.

Determinants of Exercise in Cancer Survivors

Research examining the determinants of exercise in cancer populations is limited. As such, all available studies that examined determinants of exercise were included in this review. Only three theoretical frameworks have been applied in this population, and only a few types of cancer have been examined. Two early studies were atheoretical [22, 35], one study employed the Health Belief Model [36], and another study employed the Five Factor Model of Personality and the Transtheoretical Model [37]. The most extensively used theory in this population, however, is the Theory of Planned Behavior [38-43] (See appendix B).

Overall, in four of the nine studies it was found that medical and demographic variables were not meaningful determinants of exercise during or following cancer treatment [16, 22, 39, 40]. Barriers to exercise in breast cancer patients was examined in three studies and it was found that breast cancer patients who participate in exercise reported fewer barriers to such activities then those who did not exercise [22] and that incentives tended to outweigh barriers to exercise [35]. There is also some evidence that there are differences in benefits and barriers to exercise between women who have versus those who have not experienced breast cancer [36].

In the theory of planned behavior research, several themes emerged from a review of the literature. First, intention predicted exercise behavior in all six studies regardless of the population or the design of the study [38-43]. Perceived behavioral control was found to explain significant variance in intention to exercise [41-43] as well as exercise behavior [38, 40]. Finally, although not typically thought to be an important construct for prediction, subjective norm also predicted intention in the breast cancer samples[40, 42, 43].

The theory of planned behavior has been used to examine the determinants of exercise in colorectal cancer treatment and survivorship[38, 39] (See Appendix B). Of these studies, one employed a retrospective design, with patients who had undergone adjuvant chemotherapy[38], while the second applied a prospective design for post-surgical colorectal cancer patients[39]. Intention and perceived control were found to be direct determinants of exercise during cancer treatment. It was also found that exercise pre-diagnosis was the best predictor of exercise post-diagnosis. Salient beliefs for colorectal cancer patients were found to differ from those of a healthy population in that cancer patients tended to view exercise in terms of helping them to cope with cancer [38]. The most important behavioral beliefs, or a positive or negative evaluation of performing the behavior, were: a) get my mind off cancer and treatment, b) maintain a normal lifestyle, c) recover from surgery and treatment, and d) gain control over my life, e) feel better and improve well-being f) cope with stress of cancer and treatment [38, 39]. The most salient control beliefs (i.e., the perceived ease or difficulty of performing the behavior) were: a) no time, b) experienced fatigue or tiredness, c) experienced pain or soreness [38]. The most relevant normative referents, or sources of perceived social pressure, in this population were: a) spouse, b) other family members, c) friends, and sometimes, d) physician [38, 39]. However, unlike earlier studies in breast cancer patients, in both colorectal cancer studies normative beliefs were not found to provide insight into intention to exercise, or exercise during treatment. Regardless, these salient normative referents provide insight into influential sources in the lives of colorectal cancer patients.

Results from Courneya's preliminary study on the determinants of exercise in colorectal cancer patients showed that intention explained significant variance in exercise during treatment and PBC and exercise prediagnosis explained additional variance[38]. Intention and perceived control were found to be direct determinants of exercise during cancer treatment. Attitude explained significant variance in intention and PBC did not add to this variance. Interestingly, in this study, as was found in previous studies [22], demographic and medical variables were not meaningful determinants of exercise during cancer treatment[38]. The subsequent study was completed to further test the theory of planned behavior as a tool for understanding motivation in 66 CRCs[39]. It was found that intention explained 26% of the variance in post surgical exercise, with PBC explaining only an additional 4% of variance. Further, PBC, attitude, and subjective norm explained 23% of the variance in intention to exercise, with attitude making the only unique contribution. These results indicated that cancer treatment had a negative effect on exercise levels with postsurgical colorectal cancer patients reporting less strenuous exercise in the 4-month periods following surgery then they reported prior to diagnosis[39].

Limitations of Past Research on Exercise Motivation in Cancer Survivors

While the theory of planned behavior has clearly outlined the beliefs that surround exercise intention, and in some cases behavior in CRCs, there are drawbacks to using the TPB to examine the determinants of exercise in cancer populations. The TPB neglects the importance of different beliefs in initiation or long-term adherence. The TPB also makes no prediction about how these beliefs affect psychological well-being. Further, TPB makes no attempt to include measures of motivation, or distinguish between different forms of motivation. TPB also makes no attempt to incorporate how satisfaction of needs for competence, relatedness, or autonomy could affect behavior.

Therefore, the possibility of extending this research to include another theoretical framework could expand on the current knowledge of behavioral motivation in cancer populations. Courneya acknowledges the need for testing of further theoretical models in regards to this population, citing Deci & Ryan's self-determination theory as a model that holds promise for understanding exercise behavior in cancer populations[42]. In order to develop the most efficacious interventions to increase both initiation and maintenance of exercise during cancer survivorship, it is imperative to have a comprehensive understanding of the motivation of those who are initiating, maintaining, or failing to exercise. In order to gain a full understanding of such motivation, a theoretical framework is required that will allow for examination of not only the motivation, but the antecedents of such motivation. While many models have been applied to exercise, such as The Transtheoretical Model, Social Cognitive Theory, Protection Motivation Theory, SDT is unique in that it allows for the underpinnings of the characteristics of each motivation to be studied. Applying SDT to the examination of exercise during colorectal cancer survivorship will expand the base of knowledge about the underlying motivations of CRCs.

Self-Determination Theory

Self-determination theory (SDT) is an overarching theory of human behavior that includes four sub theories, the most widely studied of which are: a) cognitive evaluation theory (CET), and b) organismic integration theory (OIT). Within this current research project OIT will be examined as a framework for understanding the orientation of a variety of forms of external motivation [44, 45]. This theory challenges the dichotomy of intrinsic and extrinsic motivation. Typically, intrinsic motivation is seen as the tendency to perform a behavior that is viewed as inherently interesting and satisfying [44, 45]. Conversely, extrinsic motivation is seen as performing an activity to attain some separable outcome [46]. However, SDT extends this view of motivation to include reasons that might not be inherently interesting but are performed because of a variety of reasons such as social pressures, or simply viewing the behavior as important [44, 45]. As such, OIT proposes that internalization of behavior motives occurs along a continuum of motivation such that the more self-determined reasons are for performing a behavior, the more autonomous that behavior. Autonomy reflects an internal locus of causality and involves a sense of personal volition, and also a recognition of the value of the activity. Conversely, the less self-determined the reasons for performing the behavior are, the more controlled the behavior. Controlled behaviors originate from an external locus of causality and tend to carry feelings of guilt and shame and compliance with external demands to perform the behavior[3, 5, 45, 46].

OIT proposes that individuals will perform different behaviors for a variety of reasons. Some actions are done with aversion, defiance, and apathy whereas more integrated behaviors are performed with willingness and recognition of the value of the task [44, 45]. The tendency to integrate behaviors is enhanced or hindered based on how social contexts thwart or foster basic psychological needs. These needs, as outlined by SDT, are perceptions of competence, relatedness and autonomy. The need for competence refers to possessing ability to deal effectively with one's environment. The need for relatedness describes feeling connected to and accepted by others. Finally, autonomy describes the perception of choice, or personal volition, in engaging in a behavior. These needs are described as being essential for the facilitation of optimal functioning, and personal well-being [44, 45].

Satisfaction, or lack thereof, of these three basic human needs (or nutriments) affects behavioral motivation in different contexts over time [44, 45]. This perspective examines the influence of social contexts on enhancing or hindering the development of the autonomy, relatedness, and competence. As social and contextual environments satisfy these needs, individuals are postulated to engage in more self-determined behavioral regulation. Conversely, need thwarting environments and contexts are believed to facilitate development of more controlling, or less self-determined, behavioral regulation.

The proposed continuum, as outlined by Deci and Ryan [3], begins with absolute lack of motivation, termed amotivation; lacking the intention to act, and often described as a state of learned helplessness [3]. The next state is external regulation, or being motivated to comply with some external demand. In an exercise context this would equate with feeling required to exercise because of instruction from a significant other. Next along the continuum lies introjected regulation, and refers to performing a behavior because of feeling compelled to do so out of guilt, avoidance of negative emotions, or to improve conditional self-worth. Introjected regulation is still considered a controlling regulation. After that is identified regulation, when there is a conscious valuing of a behavioral goal or regulation. In this case the behavior is personally endorsed and valued, despite finding the behavior itself relatively uninteresting. An example of this could be valuing the health benefits of exercise, but not enjoying the exercise in and of itself. This regulation has an internal perceived locus of causality. The most self-determined form of extrinsic motivation is integrated regulation. This regulation refers to the most autonomous form of external regulation; the behavior has been evaluated and brought into line with personally endorsed values. However, the behavior is still performed for personally important outcomes rather than inherent interest and is therefore still considered a form of extrinsic motivation. Finally, intrinsic regulation refers to performing a task based on its enjoyment and satisfaction and not on separable outcomes. For example, exercising simply because it is fun is an example of intrinsically motivated behavior[3].

While this continuum of behavioral regulation exists somewhat linearly, this does not imply that the continuum is developmental per se [44, 45]. Individuals are not thought to progress through all types of regulations. Behavioral regulations will exist at different points along the continuum, individuals can progress or regress based on the extent to which social contexts support or hinder the three basic needs[44, 45]. Previous research has illustrated support for the presence of a continuum through demonstration of a simplex pattern of relationships between the regulations. This pattern is such that regulations that are adjacent to each other (ie. external and introjected) will be more positively associated than regulations not adjacent to each other (ie. external and internal)[47-56].

It is proposed that support of satisfaction of the needs for autonomy, relatedness, and competence should facilitate more self-determined forms of behavior regulations for exercise [44, 45]. Deci and Ryan [44, 45], also maintain within OIT that satisfaction of the basic psychological nutriments is necessary for health and well-being . When these needs are not met, individuals will not experience integrity and well-being, but pathology and ill-being[45].

A more typical measure of psychological well-being within self-determination theory is Deci and Ryan's Vitality scale. This measure of subjective vitality attempts to capture a positive feeling of "aliveness and energy" [57, page 529]. Ryan suggests that contexts that support psychological need satisfaction should increase vitality[58]. Theoretically, a healthy individual who is able to function optimally should have better ability to feel alive and vital in daily life[57]. Research has shown that subjective measures of vitality correlated with personal autonomy and relatedness, but also with physical symptoms[57]. It was found that vitality was related to physical symptoms and concerns, such that better body functioning and less physical symptoms was associated with increased vitality[57]. It was also observed that morbidly obese patients who followed program guidelines, exercised more, and maintained weight loss reported higher vitality[57]. Vitality was also shown to be lower in individuals who suffer from chronic pain as compared to matched controls. This research suggested that vitality might be influenced by physical health.

SDT provides an attractive framework for studying exercise motivation. It is widely accepted, and intuitive, to view exercise as a behavior that will have both external and intrinsic regulations [59]. Even if an individual exercises because it is fun, they could still be very cognizant of the health and fitness values that are associated with exercise. Therefore, SDT provides a distinctive framework to study and understand the intricacies of the role that motivation quality plays in adoption of and adherence to exercise [59].

Additionally, by using SDT, underpinnings of motivational regulations can be investigated to gain a complete understanding of behavioral regulation [59].

Self-Determination Theory and Exercise

Empirical studies of SDT within the domain of exercise are limited. Most studies to date have been cross-sectional [4, 47-49, 54, 56, 59-65], largely based on those actively participating in exercise programs [4, 47-49, 59-61, 65], or convenience samples of undergraduate students [4, 47-49, 60, 62], designed to develop and test measurement tools [48, 56, 59, 62], and incorporate theoretical constructs outside SDT[48, 54, 64, 66, 67]. Overall, despite the heterogeneity of this body of research, there is support for the appropriateness and legitimacy of applying SDT in the exercise realm (See Appendix C).

One of the most widely studied aspects of SDT in exercise is how levels of autonomous regulations of motivation are associated with exercise behavior. Research has found that those individuals exhibiting more autonomous regulations for exercise display greater intentions to exercise, and exercise more overall [4, 47, 48, 60, 65, 66]. Additionally, several studies have reviewed how psychological well-being is associated with exercise motives. SDT suggests that more intrinsically regulated forms of motivation should be associated with greater psychological well-being [4, 44, 58]. Preliminary research has shown support for this thesis, given that extrinsic exercise motives have been correlated with poorer psychological well-being and vice versa [60, 65]. For example, Maltby and Day[60] found that individuals who had been exercising for greater than six months, scored higher on intrinsic regulations and self-esteem, and lower on extrinsic motives, somatic symptoms, anxiety, social dysfunction and depression than those who had been exercising regularly for less than six months. This is consistent with other findings indicating that psychological need satisfaction of competence and autonomy, as outlined by SDT, is associated more strongly with intrinsic exercise regulations than extrinsic exercise motivations [48].

Within SDT, as described earlier, it is contended that intrinsic regulations are associated with greater adherence to the given activity [4, 44, 58]. There has been some preliminary confirmation of this phenomenon in the exercise literature [4, 60, 66]. Ryan [4] found that competence and enjoyment motives were predictive of greater adherence and attendance to a chosen exercise activity. Similarly, Ingledew et al [66] found that individuals who had been exercising for greater than six months showed more intrinsic regulations than those exercisers who had been active for less than six months. Overall, this study also reported that intrinsic motives were important for progression and maintenance of exercise behaviors [66].

Another aspect of SDT that has received attention in the literature is perceived autonomy support, or the perception of significant others offering choice, providing a meaningful rationale, minimizing pressure, and acknowledging the target individual's feelings and perspectives [68]. Techniques to increase autonomy support have been used in several studies of health behavior from a perspective of SDT research as a method of increasing self-determined behavior [68-70]. SDT postulates that high levels of autonomy support should result in more self-determined forms of behavioral regulations [70]. Wilson & Rodgers[47] have examined the role of perceived autonomy support in exercise, and reported that perceived autonomy support from friends was more favorably associated with identified and intrinsic regulations and intention to exercise then to external regulations [47]. Williams[68] examined motivational predictors of weight-loss and weight-loss management during a comprehensive intervention which included exercise. While there were limitations with the instrument used to measure exercise, this study demonstrated that the degree to which patients experienced staff as autonomy supportive was a significant predictor of autonomous reasons for persisting in the program. In the exercise domain there is also some preliminary evidence demonstrating that lack of health pressure to exercise contributes to intrinsic motivation, as expected according to Deci and Ryan's theory [44, 66].

Autonomy supportive interventions have also been applied to other types of behaviors in clinical populations, such as attempting to improve glucose control of patients with diabetes [70]. It was found that care providers being perceived as autonomy supportive would predict improved glucose control over 12 month maintenance period [70]. This study, although not without its limitations, lends support to the application of SDT and the concept of perceived autonomy support in clinical populations.

It has been established that colorectal cancer patients are at risk for a multitude of post treatment complications and issues that can be detrimental to their QoL [6, 10, 14]. There is also support for exercise as a supportive therapy that can ameliorate some QOL issues [16, 17]. Self-determination theory is a novel addition to this area of research as it provides a unique perspective to study the quality of motivation as well as how perceived autonomy support, and demographic variables can effect such regulations in order to better understand the motivational characteristics of this population.

Purpose and Hypotheses

The purpose of the present study was to evaluate Self-Determination Theory as a framework for understanding exercise motivation and behavior in CRCs.

It was hypothesized that:

1. The intercorrelations between BREQ-2 subscales would comprise a simplex structure in accordance with Deci and Ryan's theoretical propositions[45]. This pattern is such that regulations that are adjacent to each other (ie. external and introjected) will be more positively associated than regulations not adjacent to each other (ie. external and internal)[47-56]

2. Participants endorsing more self-determined behavioral regulations were expected to engage in higher levels of exercise. This claim is in line with the theoretical propositions of SDT[4, 44, 58], and research has demonstrated preliminary support for these relationships in non-clinical populations [4, 60, 66].

3. Satisfaction of the needs for competence, relatedness, and autonomy would be positively associated with self-determined regulations for exercise behavior, and negatively associated with less self-determined regulations for exercise behavior.

4. Perceived autonomy support (PAS) would be associated identified and intrinsic motivation to exercise[47]. It is anticipated that this association will be moderated by psychological needs satisfaction[70].

5. Those who exercised regularly would experience higher QoL. Additionally, it was also hypothesized that more self-determined behavioral regulations would be associated with higher QoL.

6. Those who reported higher exercise levels would experience greater vitality. Additionally, CRCs who related more self-determined behavioral regulations would experience higher levels of vitality.

7. Medical and demographic variables will have an effect on exercise behavior. Previous research in cancer populations has found no consistent relationships between medical and demographic characteristics and exercise [16, 22, 39, 40]. Little research to date has examined interaction between medical demographics and self-determination measures in an exercise population therefore this was an exploratory analysis.

CHAPTER TWO: METHODS

Participants and Procedure

Initially, a random sample of CRCs was obtained from the Alberta Cancer Registry. Previous research has outlined the legitimacy of using cancer tumor registries as recruitment tools[16, 17, 38, 71]. Demographic profiles and physician information was collected on CRCs who a) were diagnosed with colorectal cancer, b) had their tumor completely resected and completed any adjuvant treatment for at least one year, c) were not suffering from any recurrent disease, and d) were between the ages of 20 and 80.

The first stage of this study was to approach the General Practitioner for approval to send patients the questionnaire package. In order to increase physician response, a letter, brief project overview, and list of patients to approve or deny was mailed to each physician. Two weeks following this mail out, a follow-up phone call was made to any physician who had failed to respond. All eligible patients who received physician consent for contact were mailed a package containing a cover letter explaining the research project, two consent forms, the questionnaire, and a self-addressed stamped envelope. Participants were instructed to sign and return one copy of the consent form, as well as the questionnaire at their earliest convenience. A post card reminder was sent to all non-responders one week following the original mail out, and a second questionnaire was sent two weeks following the post-card reminder to all further non-responders. In order to increase response to our survey, several methods were employed, namely, a modified version of the total design method as outlined by Dillman[72] and used in previous research [16, 17, 38, 71]. Such methods include, multiple reminders, including self addressed stamped envelopes, using personalized cover letters, colored paper, assurances of confidentiality, and displaying university sponsorship [73]. No follow-up telephone call was made because of ethical concerns of being intrusive [38]. The research design employed here was cross-sectional and observational.

Instruments

Self-determination theory

Behavioral Regulation

The Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2) was used as a measure of amotivation, external, introjected, identified, intrinsic, forms of regulation. The original BREQ was developed by Mullen et al [56] and has since been successfully tested and used several times [47-52, 74]. However, the BREQ-2 was used, due to its inclusion of amotivation. BREQ-2 is a 19 item self-report measure that was developed to measure exercise regulations consistent with SDT. The BREQ-2 is a five point Likert scale ranging from 0 ("not true for me") to 4 ("very true for me"). This scale is comprised of five subscales that assess amotivation, external, introjected, identified, and intrinsic regulations of exercise behavior. Internal consistency estimates (Cronbach's α) for the BREQ-2 subscales in present study were all within an acceptable range; amotivation regulation subscale $\alpha = .81$, external regulation subscale $\alpha = .83$, introjected regulation subscale $\alpha = .79$, identified regulation subscale $\alpha = .85$, and finally intrinsic regulation subscale $\alpha = .94$.

Perceived Autonomy Support

Perceived autonomy support (PAS) was measured through modification of the perceived autonomy support scale outlined by Deci and Ryan [3]. This self-report measure was used to assess the extent to which people who are close to the participant are perceived as autonomy supportive in regard to exercise decisions and behaviors. Friends, family, spouse, and physician have been identified in previous research as important sources of influence [38, 39]. This scale has been modified and used successfully in other SDT and exercise research [47]. The Cronbach's α score used to evaluate internal consistency for PAS was $\alpha = .89$.

Psychological Need Satisfaction in Exercise

Psychological need satisfaction was measured using the Psychological Needs Satisfaction in Exercise (PNSE) questionnaire of competence, relatedness and autonomy. This measure has been developed and tested within SDT for the purpose of testing theoretical propositions [52, 74]. Cronbach's α scores were good for all three subscales; the competence subscale $\alpha = .95$, relatedness subscale $\alpha = .96$, and the autonomy subscale $\alpha = .95$.

Exercise Behavior Questionnaire

Exercise Behavior was assessed by a modified version of the Leisure Score Index (LSI) from the Godin Leisure Time Exercise Questionnaire[75, 76]. Participants are asked to recall their average frequency and duration of mild (minimal effort, no perspiration), moderate (not exhausting, light perspiration), and strenuous (heart beats rapidly, sweating) exercise in a typical week. Participants were asked to recall activity during three separate time periods—before their diagnosis, during any adjuvant therapy (if applicable), and in the past month. For each time period, weekly exercise minutes of mild, moderate, and strenuous exercise was calculated. Following this, combined scores for moderate plus strenuous exercise and total exercise were also computed. Finally, the percentage of participants meeting the public health exercise guidelines recommended by the Centers for Disease Control and the American College of Sports Medicine was calculated[77]. These guidelines recommend that adults should obtain either 60 minutes of strenuous intensity exercise per week or 150 minutes of moderate-to-strenuous intensity exercise per week. Reliability and validity of the LSI has been found to compare favourably to nine other self-report measures of exercise based on various criteria including test-retest scores, objective activity monitors, and fitness indices[78]. The LSI demonstrated a one-month test-retest reliability of .62 and concurrent validity coefficients of .32 with an objective indicator (as measured by an accelerometer), .56 with VO_{2max} (as measured by expired gases), and -.43 with percent body fat (as measured by hydrostatic weighing).

Quality of Life

The Functional assessment of cancer therapy – colorectal (FACT-C) was used to assess QoL. This measure has been used extensively in the colorectal cancer and exercise literature, as it was developed specifically for colorectal cancer populations. Participants were asked to complete the FACT-C based on how they have felt in the last seven days. The FACT-C has five subscales that measure different dimensions of QoL including physical well-being (PWB; 7 items), functional well-being (FWB; 7 items), emotional well-being (EWB; 6 items), social well-being (SWB; 6 items), and additional concerns (AC) which address symptoms of CRC (20 items). The sum of PWB, FWB, SWB, EWB comprise the FACT-General (FACT-G) score. The sum of the FACT-G plus the AC score gives a FACT-Colorectal (FACT-C) score. The FACT scales are all rated on a 5-point Likert scale that ranges from 0 ("not at all") to 4 ("very much"). This measure has been tested in a large sample of cancer patients where it was found to have been reliable, valid, responsive, brief and easy to administer[13]. Internal consistency estimates (Cronbach's α) for the FACT-C subscales in present study were all within an acceptable range; physical well-being subscale $\alpha = .84$, functional well-being subscale $\alpha = .88$, social well-being subscale $\alpha = .89$, emotional well-being subscale $\alpha = .73$, and additional concerns subscale $\alpha = .90$.

Vitality

Deci and Ryan's Vitality scale was used as a subjective measure of vitality. The trait vitality, or ongoing characteristic of the individual, was assessed in this study. These traits are considered enduring have been found to relate positively to self-esteem and to relate negatively to anxiety and depression [57]. Internal consistency (Cronbach's α) for the Vitality scale in present study was acceptable ($\alpha = .91$).

Medical and Demographic Information

Demographic variables that were collected in this study were: a) age, b) sex, c) marital status, d) education, f) family income, g) employment status, h) height and i) weight. Medical variables collected were: a) months since diagnosis, b) stage of disease, c) surgical procedure, d) number, type, and length of adjuvant therapy f) presence of co-morbidities, g) activity limitation due to healthy condition, injury, or disability. This information was collected through self-reports.

Body mass index (BMI) was used here as an indicator of overall adiposity National Institutes of[79]. It is a general measure determined by dividing weight by height squared. BMI is generally used to classify individuals into one of four categories: a) underweight (BMI<20), b) normal/desired weight (BMI =20-24.9), c) overweight (BMI= 25-29.9), or d) obese (BMI >30). Increasing BMI into overweight and obese rages is associated with increased risk of many obesity related chronic diseases and is generally an undesirable from a health perspective National Institutes of[79].

Sample Size and Statistical Analysis

The sample size calculation was based on Cohen's guideline for correlations of 0.10= small, 0.30 medium, and 0.50 =large. In order to detect a small-to-medium correlation of 0.20 with 80% power and a two-tailed significance level of 0.05, at least 194 participants were needed. In order to complete sub-group analysis on demographic and medical variables a sample size of greater than 400 was pursued.

For the purpose of analyses, the total number of minutes of moderate plus strenuous exercise was capped at 420 minutes to eliminate outliers. This is because one hour a day of moderate and strenuous physical activity (420 minute per week) is beyond the recommended guidelines for physical activity and exercise[77]. Amounts beyond 420 minutes per week is not recommended to the general population, nor this clinical population, and may be the result of measurement error.

Pearson Correlation Coefficients were used to examine bivariate relationships between the major SDT variables in order to examine if the data fits the proposed simplex structure pattern{4, 47, 50, 60, 65}. Pearson correlations were conducted to examine any possible associations between the continuous demographic (e.g., age, BMI) or medical (e.g., months since diagnosis) variables and the SDT constructs or exercise behavior[49].

Path analysis techniques were used to estimate the magnitude of the direct and indirect effects proposed in SDT[80]. Hierarchical regression analysis (HRA) was used such that, six multiple regression models were tested. First, exercise behavior was regressed on the five behavioral regulations, the three psychological needs, and perceived autonomy support. Second, each of the five behavioral regulations was regressed on the three PNSE for competence, relatedness, and autonomy, followed by PAS. To complete the path model, bivariate correlations between PAS and PNSE were examined. Previous SDT and behavior research has employed path analysis[54, 55, 63, 81, 82] and HRA[4, 51, 61, 81, 82].

Finally, the relationships between QoL, vitality measures, and exercise behavior were tested using bivariate correlations. Following which, both QoL and vitality were regressed on exercise behavior, the behavioral regulations, and finally PNSE to determine if the underlying behavioral regulations influence psychological well-being beyond the effects of exercise behavior itself. These HRA analyses results were used to present a path model.

CHAPTER THREE: RESULTS

Eligibility and Response

A random sample of 1498 eligible participants was identified through the Alberta Cancer Registry. Figure 1 provides a detailed summary of participant eligibility and response. General practitioners for each participant were subsequently contacted to obtain permission to contact each patient. Out of all potential participants, 809 were cleared with permission to contact, 689 were excluded. Reasons for participant exclusion were: the physicians of 524 participants did not respond to the request to contact, physicians of 39 participants had invalid addresses, physicians of 16 participants had retired, physicians of 11 participants were on leave, physicians of 8 participants were not listed, 9 participants were granted permission following the cutoff date. Eighty-two participants had their physician deny the request to contact. For individuals who received non-approvals, 13 participants were deceased, 18 participants had progressive disease or were too ill, 4 participants had emotional or psychological issues, 1 participant did not have cancer, 2 participants did not speak/write/read English, 1 participant was an alcoholic, physicians of 10 participant were not the primary treating physician, and physicians of 33 participants did not provide a reason.

A total of 809 questionnaires were mailed out. Following which 368 participants were excluded; 247 did not reply, 122 participants had an invalid address. Subsequently, 440 questionnaires in total were returned. Of those participants who reported reasons for non-response, 6 were deceased, 2 suffered from advanced disease, 4 were not interested, 2 did not speak English, 5 did not have colorectal cancer, 1 had a spouse recently pass away, 5 gave no reason, and one was returned following the cut-off date. Overall, 414

CRCs returned a completed survey and were included in the analysis. The response rate was calculated as 61.4% (414/674) which excludes from the denominator the 122 returned surveys, the six deceased persons, the five persons without colorectal cancer, and the two persons that did not speak English.

Demographic and Medical Characteristics

The demographic and medical characteristics of all participants are shown in Tables 1 and 2 respectively. In summary, the mean age of participants was 60 (SD 7.5, n=408), 54% were male (n=224), the large majority were married or common law (n=335, 85.7%), 22% completed university or college (n=81), and the majority were either retired (n=180, 43.5%) or employed full/part time (n=181, 43.8%). The average Body Mass Index (BMI) was 29.0 (SD 5.5, n=338). The preponderance of respondents were colon cancer survivors (n=318, 76.8%), the majority were unsure of the stage of their disease (n=198, 47.8%), 62.3% received chemotherapy (n=258), and almost all participants underwent surgery (n=405, 97.8%). The majority of participants did not feel their physical activity in the past month was limited by a health condition, injury or disability (n=271, 65.5%). Of the list provided, the other main chronic illness reported by participants were high blood cholesterol (n=145, 35.0%) and high blood pressure (n=157, 37.9%). Tables 3 and 4 present the descriptive data for exercise behavior and SDT variables. Notably, within this sample only 25.8% of participants were meeting ACSM's guidelines for physical activity.

Demographic and Medical Variables Association with SDT Variables

Table 5 presents the bivariate correlations between demographic characteristics and self-determination and exercise variables. Generally, demographic variables showed small associations with SDT variables and exercise behavior.

Table 6 presents the bivariate correlations between medical and SDT and exercise variables. Overall, the correlations found were generally small, and most medical demographics did not reveal significant relationships with SDT variables or exercise behavior. Notably, higher body mass index was associated with higher levels of amotivation (r=.15, p<.01) and external motivation (r=.21, p<.001), as well as lower levels of identified (r= -.16, p<.01) and intrinsic motivation (r= -.23, p<.001). Higher BMI was also associated with lower PNSE competence (r= -.12, p<.05) and perceived autonomy support (r= -.20, p<.001), as well as overall exercise behavior (r= -.13, p<.05). Type of cancer, having had surgery, having received chemotherapy, having received radiation therapy, having had surgery plus adjuvant treatment displayed no significant relationships with SDT variables or exercise behavior.

Bivariate Correlations Among SDT Variables

Behavioral Regulation in Exercise Questionnaire – 2 Inter-Scale Correlations

The correlations amongst the BREQ-2 subscales, representing behavioral regulations, supported the ordered pattern of relationships expected based on Deci and Ryan's SDT. Namely, the subscales of behavioral regulation that lie adjacent to each other along the motivational continuum were more positively correlated then those non-adjacent to each other on the motivational continuum[83]. Correlations ranged from small to large, and reflected these relationships (Table 7, Figure 2).

Associations Between PNSE and Behavioral Regulation

Table two presents bivariate correlations used to examine the extent to which the needs satisfaction for competence, relatedness, and autonomy were correlated with more self-determined behavioral regulations for exercise. There were positive and significant correlations between identified and intrinsic regulations and all three psychological needs satisfactions. There were significant negative relationships between psychological needs satisfaction and amotivation regulation. External regulations were negatively correlated with psychological needs satisfaction for competence and autonomy. Introjected regulation also had a significant positive relationship with PNSE relatedness[44, 45]. PNSE subscales displayed large and positive intercorrelations (Table 7).

Associations Between PAS and Behavioral Regulation

Bivariate correlations were used to examine the relationships between PAS and behavioral regulation. PAS was positively correlated with identified ($r=.47$, $p<.001$) and intrinsic regulations for exercise ($r=.51$, $p<.001$) and negatively associated with introjected ($r=-.10$, , $p<.05$), external ($r=-.20$, $p<.001$) and amotivated ($r=-.32$, $p<.001$) regulations for exercise (Table 7).

Associations Between SDT and Exercise Behavior

The main hypothesis concerning SDT and exercise behavior was tested using hierarchical regression analyses (HRA) with forced entry at each step, which was then used to present path analysis. The order and content of each step was based on the theoretical outline of SDT[84]. In the first HRA, exercise behavior was regressed on the five behavioral regulations (amotivation, external, introjected, identified, intrinsic), followed by the three psychological needs satisfaction (competence, relatedness, and autonomy), and finally perceived autonomy support (Table 8). Results of the first HRA indicated that behavioral regulations explained 25% of the variance in past exercise behavior with identified (β=.31, p<.001) and intrinsic (β=.15, p<.05) regulations making significant individual contributions. PNSE explained an additional 3% of the variance in past exercise behavior, with the need for relatedness making a significant individual contribution (β=.12, p<.05). Adding PNSE to the equation changed the contribution of behavioral regulations such that intrinsic regulation was no longer a significant unique contributor, however, identified regulation remained significant (β=.27, p<.01). Finally, adding PAS explained no additional variance in exercise behavior and did not significantly alter the unique contributions of identified regulation (β=.26, p<.01) or PNSE for relatedness (β=.11, p<.05).

As a summary of the overall findings, we present a path model of the relationships among the theoretical constructs within SDT and exercise behavior[84]. The approach taken here is referred to as theory trimming where all paths are tested, but only the significant ones are included[84]. A path diagram is presented based on the final model from each of the six HRAs (Figure 3).

In the second to sixth HRAs, each of the behavioral regulations were regressed on psychological needs satisfaction for competence, relatedness and autonomy, followed by perceived autonomy support. For amotivation, the results indicated that PNSE explained 11% of the variance (F(3, 410) = 16.15, p<.001), with psychological needs satisfaction for competence having the only significant unique contribution (β= -.18, p<.01). Addition of PAS to the equation added a significant 3% to the explanation of variance in amotivation ($F(1, 409) = 16.92$, $p<.001$; Table 9) and only slightly altered the contribution of satisfaction of the need for competence ($\beta= -.15$, $p<.05$).

For external regulation (Table 10), PNSE explained 5% of the variance ($F(1, 410) = 6.69$, $p<.001$). Only PNSE for autonomy made a significant unique contribution ($\beta=-.18$, $p<.01$). The addition of PAS to the equation added 6% to the explanation of variance ($F(1, 409) = 6.67$, $p<.05$). At this step, the only significant contributions remained from PNSE for autonomy ($\beta= -.15$, $p<.05$) and PAS ($\beta= -.14$, $p<.05$).

For introjected regulation, (Table 11), PNSE explained 4% of the variance ($F(3, 410) = 5.15$, $p<.01$) with significant unique contributions from needs satisfaction for relatedness ($\beta=.17$, $p<.01$) and autonomy ($\beta= -.16$, $p<.01$). The addition of PAS explained an additional nonsignificant 1% of the variance. Needs satisfaction for relatedness ($\beta=.15$, $p<.05$) and autonomy ($\beta=.19$, $p<.01$) continued to have significant unique contributions, with PAS also making a significant contribution ($\beta=.11$, $p<.05$).

PNSE explained 23% of the variance in identified regulation ($F(3, 410) = 41.5$, $p<.001$). Satisfaction of the needs for competence ($\beta=.31$, $p<.001$) and relatedness ($\beta=.19$, $p<.001$) had significant unique contributions (Table 12). Addition of PAS increased explanation of variance by 8% ($F(1, 409) = 44.55$, $p<.001$). Needs satisfaction for competence($\beta=.26$, $p<.001$) and relatedness ($\beta=.13$, $p<.01$) maintained significant unique contributions, and PAS also contributed significantly ($\beta=.32$, $p<.001$).

Finally, for intrinsic regulation (Table 13), PNSE explained 4% of the variance with needs satisfaction for both relatedness ($\beta=.17$, $p<.01$) and autonomy ($\beta= -.16$, $p<.01$) being unique contributors. When PAS was added, it explained an increase in 1% of the variance (F(1, 409) = 3.93, p<.05), with needs satisfaction for relatedness and autonomy remaining significant unique contributors (β=.15, p<.05; β=.19, p<.01), and PAS also contributed significantly (β=.11, p<.05).

Quality of Life

Associations Between Exercise Behavior and QoL

Table 14 presents bivariate correlations between exercise behavior and QoL. Minutes of moderate plus strenuous physical activity were significantly positively correlated with the FACT-C (r=.16, p<.01), and FACT-G (r=.13, p<.01). In regards to the subscales, physical well-being (r=.18, p<.001), functional well-being (r=.11, p<.05), and additional concerns (r=.17, p<.001) each had significant positive correlations with minutes of moderate and strenuous exercise in the past month.

Associations Between QoL and Self-Determination Theory

Hierarchical regression analysis was used such that, QoL was regressed on exercise, followed by the five BREQ-2 subscales, and finally PNSE for competence, relatedness and autonomy. Forced entry was used within each step. The order of steps was employed to determine the mediating effect of exercise on QoL. Overall, 24% of the variance in QoL was explained. Results indicated that exercise accounted for 3% of the variance (F(1, 412) = 11.23, p<.01; Table 15). The addition of the five behavioral regulations explained an additional 12% of the variance (F(5, 407) = 11.38, p<.001). External (β= -.12, p<.05), introjected (β= -.18, p<.01), and intrinsic (β=.20, p<.01) regulations each made significant unique contributions. Finally the addition of PNSE for competence, relatedness, and autonomy accounted for an additional 10% of the variance (F(3, 404) = 16.83, p<.001). Needs satisfaction for competence made the most significant contribution (β= .30, $p<.001$), followed with autonomy (β= .12, $p<.05$). External regulation also remained a significant unique contributor (β= -.10, $p<.05$). A path diagram of these findings is presented in Figure 4 based on the final results of each HRA.

Vitality

Associations Between Vitality and Exercise Behavior

Bivariate correlations between vitality and self-reported moderate plus strenuous minutes of exercise in the past month were examined. Correlation between vitality and moderate plus strenuous minutes of exercise was positive and significant (r=.23, $p<.001$; Table 9).

Associations Between Vitality, Behavioral Regulation, and PAS

Hierarchical regression analysis was used to examine the relationships between behavioral regulation, PAS, and vitality (Table 16). Forced entry was used within each step, and the order and content of the steps was based on the theoretical hypothesis put forth by SDT [57]. Vitality was regressed on the exercise behavior, followed by the five BREQ-2 subscales, and finally by the three PNSE subscales. Overall, 35% of the variance in vitality was explained. In the first step, exercise explained 5% of the variance in vitality ($F(1, 412) = 22.98$, $p<.001$). Behavioral regulation explained an additional 15% of the variance in vitality ($F(5, 407) = 14.84$, $p<.001$). External regulation (β=.13, $p<.05$), introjected regulation (β=.17, $p<.01$), and intrinsic regulation (β=.30, $p<.001$) all made significant unique contributions. In the second step, psychological needs satisfaction explained an additional 15% of the variance ($F(3, 404) = 32.00$, $p<.001$). The only BREQ-2 subscales to continue significantly contributing were external ($\beta=-.10$, $p<.05$) and intrinsic regulation ($\beta=.19$, $p<.01$). Psychological need satisfaction for competence ($\beta=.38$, $p<.001$) as well as autonomy ($\beta=.14$, $p<.01$) were found to be significant unique contributors to the explanation of variance in vitality. Subsequent to HRA, results were used to complete a path diagram presented in Figure 5.

CHAPTER 4: DISCUSSION

The purpose of this study was to apply Self-determination Theory to a population-based sample of CRCs to understand exercise motivation and behavior. Within this sample of CRCs, only 25.8% of the population was meeting public health guidelines[77]. These results are similar to those found in previous research in breast[85], endometrial[86], non-hodgkins lymphoma[87], and multiple myeloma[88] cancer survivors where 20-31% were meeting public health exercise guidelines. Clearly research investigating exercise motivation in cancer survivors is warranted. Overall, this study provides support for the application of SDT in this sample of CRCs. In general, the constructs of SDT performed within accordance of the theory in this population. Identified regulation as well as PNSE for relatedness were recognized as important correlates of exercise behavior in this population. The most important contributors to each of the motivational regulations were outlined. Finally, the support for the potential applicability of QoL in SDT and cancer research was found.

Self-Determination Theory Variables

BREQ-2

The first hypothesis, that intercorrelations between BREQ-2 subscales would comprise a simplex structure in accordance with Deci and Ryan's theoretical propositions was supported, such that regulations proximal to each other within the continuum would have more positive associations then those distal to each other. These relationships were similar to intercorrelations presented in previous research[47, 49-52], and those proposed by the designer of the scale[83]. This is important, because it lends support to the concept of a motivational continuum in the context of exercise, as is proposed by Deci and Ryan[45].

Associations Between SDT Variables and Exercise in CRCs

Path Diagram For SDT and Exercise Behavior

Following the HRA, path analysis was performed which included the examined tenants of SDT. This path diagram (Figure 3) indicated that only identified regulation and perceived satisfaction of the need for relatedness held independent associations with exercise behavior. Previous research has found similar results for identified regulation in both male and female undergraduate students[47, 48, 50]. It should be noted here that within this sample identified and intrinsic regulation were highly correlated. While this correlation was not beyond the limit of what is considered very problematic, it is still possible that multicollinearity affected the results of these analyses in terms of the practical prediction as well as theoretical interpretations[84].

It has been proposed that when a target behavior is not considered inherently interesting yet is deemed important, the extent to which the behavior is integrated with personal values is more relevant than enjoyment [89, Vallerand, 2002 #22, 90]. By definition, goals for an intrinsically motivated individual tend to be spontaneous, absorbing, with lack of reflection on the meaning, significance or value of the activity[89, 91]. For this population, medical needs such as ostomy appliances, irregular bowel movements, or chronic fatigue could mean exercise would have to be planned and scheduled according to symptom management and time allowances [6, 10]. This could render intrinsic motivation a very difficult, and perhaps unattainable regulation for this population reach in regards to exercise.

It is possible that exercising as a result of consciously valuing the behavior is more reliably associated with exercise in this population. Previous research in colorectal cancer patients has demonstrated that patients tended to view exercise in terms of helping them cope with cancer and its multitude of side effects[38]. Colorectal cancer is considered a chronic illness with multitude of short and long-term effects of treatment[6, 10]. Therefore, integrated regulation might be a more important correlate in this group because it reflects the conscious evaluation of how exercise is viewed in relationship to disease.

Historically, identified regulation was not considered as desirable a behavioral regulation as intrinsic motivation[45]. However, recently it has been hypothesized that identified regulation can be associated with long-term integration of an initially uninteresting behavior, resulting in improved long-term adherence to the behavior[89]. Previous research has associated identified regulation with higher exercise levels, more positive attitudes towards exercise, and higher overall physical fitness[51]. It has even been theorized that identified regulation could nurture advantageous patterns of behavioral adherence as well as psychological well-being[58]. This implies that complete internalization of behavioral regulation is not required to attain the benefits of improved behavioral adherence. Identified regulation illustrates commitment to an activity based on its meaning in relation to goals, values, identity [89, 91]. This could render identified regulation a realistic and beneficial behavioral regulatory style for this population. Identification is also theorized to keep one oriented toward long-term significance of the undertaken activity [89, 91]. Therefore, endorsing identified regulation could facilitate long-term adherence to exercise participation.

Within the model proposed here, needs satisfaction for relatedness was not hypothesized to have a direct effect on behavior. Instead, the effect of needs satisfaction for relatedness on exercise behavior was hypothesized to be mediated by behavioral regulation. Needs satisfaction for competence, relatedness, and autonomy are theorized to influence the development of more internalized motivations[92]. Based on these theoretical assumptions, it was proposed here that psychological needs satisfaction would not have a direct association with behavior. However, the path analysis suggests that needs satisfaction for relatedness was directly associated with exercise behavior.

Ryan and Deci[44] purport that providing a sense of belongingness and connection to important others is a central process in the internalization of behavioral motivation. Further, it is suggested that for behaviors not deemed inherently appealing, the main reason an individual would partake in the behavior would be based on an external prompt from an important source be it peers, family, or friends with whom the individual feels connected to[44]. It is possible that for CRCs a sense of relatedness, or such an external prompt is powerful enough to be associated directly with exercise. Interestingly, previous research has found that satisfaction of the need for relatedness was not important for predicting exercise behavior[48]. However, this research used only a single item measure for each of the psychological needs, therefore the finding could be a result of a limited measurement tool. Previous SDT research in an exercise setting tended to focus more on competence, body-related, and self-esteem consequences in relation to exercise motivation[4, 49, 54, 61]. The need for relatedness has not been widely studied in an exercise context. It could be that for this clinical population, feeling support from important others is a very important determinant of exercise behavior. However, this finding is still not in line with the theoretical propositions of SDT, and needs to be explored further in future research.

The entire model used to test SDT and exercise behavior in CRCs explained 28% of the variance in exercise behavior. Within the theory of planned behavior literature, a range of 14% [40] to 68%[41] has been explained in caner populations, with most studies explaining between 30% and 40 % of the variance in exercise behavior [42]; K. S. Courneya, Friedenreich, C.M., 1997a;[93]. Previous research in CRC populations found that TPB predicted 30% of variance in postsurgical exercise[17], 40% of exercise during colorectal cancer treatment [38], and 20% of exercise during a home based randomized controlled trial [38]. It appears that TPB is more effective than SDT at explaining variance in exercise behavior in CRCs. However, this is the first known application of SDT and exercise in a clinical exercise population.

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Behavioral Regulation and Exercise

One main hypothesis of the present study was that CRCs who exhibit more self-determined behavioral regulations would engage in higher levels of exercise. Overall, behavioral regulations explained 25% of the variance in exercise behavior in CRCs. Previous research in non-clinical physically active populations has shown that behavioral regulation explained 20% of variance in exercise for men and 35% for women[50]. In regards to other constructs, behavioral regulation has been shown to explain, and 49 % and 53% of the variance in behavioral intention to exercise[47, 50], 49% of the variance in effort/importance of exerisce[50], and 15% of the variance in exercise dependence[81].

Overall, it appears that BREQ is more effective at explaining variance in exercise behavior and related constructs in younger, active populations than in CRCs. However, at this point few articles have used HRA or structural equation modeling to determine the ability of BREQ to explain variance in exercise behavior especially in clinical populations.

Associations Between PNSE and Behavioral Regulation in CRCs

Deci and Ryan postulate that satisfaction of the psychological needs for competence, relatedness and autonomy affect behavior motivation within different contexts over time[44]. More satisfaction of universal nutriments of competence, relatedness, and autonomy should be associated with more autonomous forms of behavioral regulation[44, 45]. Conversely, need thwarting, or lower levels of psychological needs satisfaction should result in less self-determined regulations. It was hypothesized for this study that the extent to which needs for competence, relatedness, and autonomy are satisfied would positively correlate with self-determined regulations for exercise behavior.

Within this sample, bivariate correlations found moderate to strong positive relationships between identified and intrinsic regulations and all three psychological needs, further supporting Deci and Ryan's claims that satisfaction of psychological needs is related to the more internalized forms of behavioral motivation[58]. These findings are also consistent with previous research which found all three psychological needs were more positively associated with identified and intrinsic regulations then less self-determined behavioral regulations[48]. Other research has also found that both satisfaction of the needs for competence and autonomy, but not relatedness, were positively associated with more internalized forms of motivation[48, 51]. It appears from the findings of the current study that needs satisfaction for competence had the strongest relationship with autonomous regulations. This is consistent with previous research detailing needs satisfaction for competence as an important predictor of behavioral regulation[65, 74]. Amotivation exhibited moderate negative relationships with all three psychological needs. This provides support for the theoretical basis of amotivation, such that lack of satisfaction of all psychological needs in an exercise context is related to a state of behavioral apathy.

Further to analysis of bivariate correlations, each of the behavioral regulations was regressed on psychological need satisfaction. Given that only identified regulation was significantly associated with variance in exercise behavior it is really the only behavioral regulation of direct interest. However, based on the limited research to date on SDT and exercise in clinical populations, especially cancer populations, the underpinnings of all behavioral regulations warrant investigation and discussion.

PNSE for competence was the only need to explain a significant amount of variance in amotivation. Low levels of needs satisfaction for competence were associated with a state of behavioral apathy; therefore, interventions aimed at increasing satisfaction of the need for competence could be helpful in motivating cancer survivors to initiate an exercise program. Given that a large portion of this population reported no minutes of moderate or vigorous exercise on the GLTEQ (51%) amotivation could be an important regulation for this group. In terms of clinical practice this could mean that individuals with no intention to exercise and no interest or belief in the benefit of exercise could require interventions targeted to improving skill acquisition (increasing competence). PNSE for competence also displayed the most significant relationship with identified regulation, which in turn was the strongest, and a positive, correlate of exercise behavior. Therefore, needs satisfaction for competence appears to play an important role in exercise behavior for this population. Previous research on SDT in the exercise domain has also outlined needs satisfaction for competence as the most important predictor of behavioral regulation [65, 74]. Interventions aimed at increasing satisfaction for the need for competence could not only curb learned helplessness but also help CRCs adopt a beneficial regulatory style for exercise.

Autonomy had significant negative relationships with external and introjected and was significantly positively associated with intrinsic regulation. These relationships are in accordance with Deci and Ryans postulations, and illustrated the possible clinical implications of helping CRCs improve satisfaction of the need autonomy in the context of exercise. It is possible that interventions aimed at increasing PNSE for autonomy (eg. education about exercise choices, provide support for individuals making their own choices) could facilitate progression along the motivational continuum for those individuals exhibiting more controlling regulations.

Finally, needs satisfaction for relatedness was positively associated with introjected, identified, and intrinsic regulations. According to SDT, Higher levels of needs satisfaction for relatedness should be associated with identified and intrinsic regulations[94]. Self-Determination Theory postulates that increased needs satisfaction for relatedness should be associated with more self-determined motivational states. Deci and Ryan maintain that needs satisfaction for relatedness, while not pertinent for intrinsic motivation, is an important psychological need for identified regulation. It is purported that needs satisfaction for relatedness may serve as an underlay for internalization, and is therefore important in behavioral persistence [91]. However, in this case needs satisfaction for relatedness also positively associated with the controlling introjected behavioral regulation. It has been theorized that needs satisfaction for relatedness and autonomy are the most important psychological needs for introjected and intrinsic regulations[45]. However, there are inherent differences between how satisfaction of these needs is obtained from the two regulations. Individuals motivated from introjected regulations tend to have the need for relatedness satisfied through feelings of guilt or conditional love[5]. The individual likely would rather not have to perform the activity, but feels pressured to do so in order to achieve acceptance. Therefore, while there might be increased needs satisfaction for relatedness, in the case of introjected regulations it is often at the expense of fulfillment of autonomy. This "pitting" of needs against one another [89page 106] typically results in less internalized behavioral regulation[89, 91].

Based on these findings, the hypothesis that increased PNSE was associated with more self-determined behavioral regulations was generally supported. Further, this provides preliminary data regarding the profile of the behavioral regulations in CRCs which could have an important implications for clinical practice and future interventions.

PAS, SDT and Exercise

The concept of autonomy support has received attention in SDT literature as an effective means of improving the quality of motivation for clinical populations[68-70, 95]. Perceived autonomy support has been described as the ability of an authority figure to, "take the perspective of the patients into account, provide relevant information and opportunities for choice, and encourage the patients to accept more responsibility for their health behaviors"[69, page 238]. Deci and Ryan postulate that increased perceived autonomy support from authority figures or important others consequently increases the likelihood that target individual will internalize and integrate motivation for the given behavior [3].

Previous research in clinical settings regarding perceived autonomy support has demonstrated that the degree to which patients experienced staff as autonomy supportive was a positive predictor of autonomous reasons for adhering to the program[68]. Subsequently, autonomy was associated with greater attendance at weekly meetings, more weight loss, and better long-term weight loss maintenance[68]. PAS has also been applied to medical education settings where it was shown that increases in the level of autonomy support shown by the supervisor led to development of identified regulations among medical students[95]. Similar findings were shown in diabetes patients such that increased perceptions of autonomy support from a health care provider significantly predicted better clinical outcomes over 12 months[70]. Williams also maintained that increasing autonomy support is especially pertinent in chronic conditions because of the likelihood of motivation to effect behavior, which ultimately effects health outcomes[70].

Associations Between PAS and Behavioral Regulation in CRCs

It was hypothesized that PAS would be associated with more identified and intrinsic motivational regulations to exercise. Examination of bivariate correlations between PAS and behavioral regulation in this sample provides initial support for these claims. It was found that PAS from important others exhibited strong significant positive correlations with identified and intrinsic regulations for exercise. Conversely, PAS was significantly negatively associated with introjected, external, and amotivation behavioral regulations. This is consistent with previous research that found PAS was more strongly associated with identified and intrinsic regulations then the less internalized behavioral regulations[47]. Subsequently, regression analysis was used to examine how PAS was associated with behavioral regulation. Perceived autonomy support was significantly correlated with all behavioral regulations independent of psychological need satisfaction, explaining an additional 3 – 8% of variance in different behavioral regulations.

There has been very little research examining the specific associations between PAS, psychological needs satisfaction, and behavioral regulation in regards to exercise behavior[47]. Research in patients with diabetes has provided support for the possibility of the mediating effects of psychological needs satisfaction on behavioral regulation[70]. Specifically, increases in PAS showed significant positive associations with autonomous motivation and perceptions of competence. Perceptions of competence as well as autonomous regulations were associated with positive physiological changes over 12months[70]. However, there has been no research to examine the possible mediating effects of PNSE on PAS and behavioral regulation in the exercise domain. The model proposed here did not expect PAS to have a direct relationship with behavioral regulation. However, it appears based on the path analysis that the association between PAS and behavioral regulation was not mediated by PNSE. Previous research with no measure psychological needs satisfaction has shown a direct association between PAS and behavioral regulation[47]. Therefore, the present work lends further support that PAS has direct associations with behavioral regulation.

As expected by the theoretical postulates of SDT, negative relationships were found between amotivation, external regulation and PAS[44]. Conversely, PAS was positively associated with identified, and intrinsic motives to exercise. All of these relationships are in accordance with the hypothesized results, previous research, as well as the tradition of SDT[47]. However, there was also a positive relationship between PAS and introjected regulation. Previous research has shown no relationship between PAS and introjected regulation[47]. However, research concerning PAS and exercise regulations is limited. The association found here could be based on the same reasoning as presented above for why PNSE for relatedness was positively associated with introjected regulation. Perhaps in the case of introjected regulation, PAS for exercise evoked feelings of pressure and guilt to comply with the demands of the source of autonomy support. This could consequently result in a less internalized motivational regulatory style. This could have important implications in future interventions. While PAS is positive in most situations, there could be circumstances where increasing PAS could be viewed as impeding autonomy. In such cases it would be important to provide further support or intervention (aimed at improving perceptions of autonomy, or competence) to help individuals develop more self-determined regulatory styles, which should help with long-term behavioral persistence and psychological well-being.

The strongest relationships for PAS were with amotivation and identified regulation. The relationship with amotivation reveals the possibility that increasing the degree to which important others encourage independent choice, and participation in decisions could help CRCs initiate exercise. Again, given the high percentage of individuals in this sample who report no physical activity, interventions incorporating increased PAS could serve as an effective means of helping CRCs initiate exercise. It also seems that PAS has a moderate direct association with identified regulation, which had the strongest association with exercise behavior. It appears that PAS could help individuals understand and accept the value of exercise. This is not surprising, given that an important aspect of PAS is providing a meaningful rationale for behavior and emphasizing the personal importance of the target behavior[69]. As discussed previously, this could be an important path to helping survivors of colorectal cancer exercise regularly.

Associations Between PAS and PNSE in CRCs

PAS also had strong positive bivariate correlations with each of the psychological needs. This is not surprising given that there were significant intercorrelations between each of the psychological needs. This illustrates that increasing perceived autonomy support could actually influence satisfaction of the needs for competence, relatedness and autonomy, as well as having a direct influence on behavioral regulation in an exercise setting.

Overall PAS had direct associations with all of the behavioral regulations independent of PNSE. This provides preliminary support that PAS could be an important intervention tool when attempting to have CRCs initiate exercise, or to help CRCs adopt a more self-determined motivational regulation.

Associations Among SDT, Exercise, Quality of Life and Vitality in CRCs

Based on the findings of previous research, it was expected that those who exercise more regularly would experience higher QoL[20, 28, 30] and higher vitality. As seen in previous research, individuals in this study who reported higher levels of exercise also experienced higher QoL. Specifically, bivariate correlations illustrated that physical well-being, functional well-being, and additional concerns subscales all had significant positive relationships with minutes of moderate and strenuous exercise. This has been demonstrated several times in previous exercise, colorectal cancer, and QoL research[16, 17, 28]. Similarly, vitality was significantly positively correlated with exercise behavior.

While QoL has not to date been used in conjunction with SDT, this study sought to examine the potential relationship between behavioral regulation, psychological need satisfaction and QoL in CRCs. It was also hypothesized that those who endorsed more self-determined regulatory styles would also experience higher QoL and vitality. Deci and Ryan maintain that increasingly internalized motives, and increased psychological needs satisfaction will subsequently increase psychological well-being. In a SDT setting, psychological well-being refers to a multidimensional phenomenon which encompasses feelings of happiness and satisfaction with life, as well as meaningfulness and integrity[96]. Specifically, this viewpoint purports that fulfillment of the three basic psychological nutriments of competence, relatedness and autonomy are essential for psychological growth, living with integrity, and overall well-being[96]. Overall, SDT uses these needs to outline the requirements for a specific context, situation, or environment to foster or thwart psychological well-being. This theory does not claim that all needs are equally important in all cultures, contexts, or relationships, but that all three needs are universal[96].

Results from the present study support the suggestion that increased psychological need satisfaction is associated with increased QoL and vitality independent of exercise behavior and behavioral regulation for exercise.

It was found that independent of exercise, needs satisfaction for competence had a moderate direct association with QoL, followed by external regulation and autonomy having small direct associations with QoL. While the model proposed here did not hypothesize direct associations between PNSE and QoL, satisfaction of needs for both competence and autonomy were directly associated with QoL. BREQ-2 and PNSE together explained about 24% of the variance in QoL independent of exercise. Considering the multifactoral nature of QoL, this level of explanation is quite reasonable.

It was also found that intrinsic regulation was positively associated with vitality, whereas external regulation was negatively associated with vitality. Interestingly, Ryan claims that needs satisfaction for autonomy should be the strongest predictor of vitality, however in this sample needs satisfaction for competence was the strongest correlate of vitality[96]. It could be that feelings of satisfaction for competence are more important in an exercise context because of the involvement of physical and functional skills. Also, because physical and functional ability tends to be compromised in CRCs, it is possible that needs satisfaction for competence could be a more salient factor in vitality for this population[14].

Interestingly, within this sample BREQ-2 and PNSE for competence, relatedness and autonomy performed remarkably similarly in predicting vitality as they did in predicting QoL. Behavioral regulation and psychological needs satisfaction predicted 35% of the variance in vitality, independent of level of exercise. External regulation negatively predicted vitality and intrinsic regulation positively predicted vitality. For both QoL and vitality, satisfaction of the needs for both competence and autonomy were significant predictors of vitality, with competence having the strongest association. This lends further support to suggest that QoL is an appropriate addition to clinical SDT research.

These results are not entirely surprising. Previous research has found that physical and functional aspects of QoL are the most important yet the least possessed facet of QoL for CRC survivors[14, 38, 39]. Feeling competent with respect to reaching valued goals has also associated with enhanced well-being[96]. Given that satisfaction of the need for competence in this context generally refers to the ability to complete, and feel confident completing, challenging exercises it is reasonable to suggest that this needs satisfaction for competence measure would elicit some associations with physical and functional well-being, which has historically been sited as important for QoL in CRC survivors[14, 38, 39]. This data suggests that interventions to increase perceptions of needs satisfaction for competence could positively impact QoL.

These results are promising because they propose that PNSE for competence is important in how CRC survivors view the quality of their lives and the level of vitality they experience. This finding could have important implications for interventions aimed at increasing QoL, such that improving feelings of ability and confidence in exercise could ultimately positively impact QoL. However, these results should be viewed with caution since differences in perceptions of needs satisfaction for competence could be the result of differing levels of disease and overall heath status. Individuals who are healthier could feel more competent and autonomous in their exercise decisions; however, it is their improved health status that is actually responsible for improved QoL.

This study offers some preliminary support for incorporation of QoL with SDT. External regulation had a negative relationship with QoL while, PNSE for competence and autonomy had positive associations with QoL. It is possible that interventions designed to positively impact perceptions of needs satisfaction for competence in an exercise setting could impact QoL. Further research designed to examine the effects of behavioral regulation and psychological need satisfaction on QoL is required to tease out possible role of SDT in QoL research.

Medical and demographic characteristics

Overall, there were no consistent associations between the demographic characteristics and exercise or SDT. As has been demonstrated in previous research, in this population most medical variables were only minimally associated with exercise behavior or SDT variables in CRCs[16, 22, 39, 40]. Only BMI displayed consistent associations with exercise behavior and SDT variables.

Demographic characteristics for this group had weak correlations with SDT variables. Generally, being female was associated negatively with amotivation and positively with needs satisfaction for relatedness. This could be an indicator that females place more importance on belonging and their exercise companions than males. Marriage was positively associated with PNSE for both competence and relatedness. It was surprising PAS was not positively associated with being married. Employment status was positively associated with PNSE for competence and autonomy. It could be that individuals who are employed and possibly active within society would feel more competent and choiceful in their exercise decisions. It does not appear that employment status is related to exercise behavior, which suggests that the demands of full or part-time employment do not affect time available for exercise. Higher family income was also associated with more exercise behavior; this too was not surprising given that increasing income and socioeconomic status has been shown to relate positively to exercise behavior[97, 98]. Education displayed a negative relationship with amotivation, and positive relationships with identified and intrinsic regulations as well as exercise behavior. This displays the possibility that higher levels of education are associated with more integration of behavior along the motivational continuum.

Although previous research has shown no relationship between BMI and behavioral regulation [49], within this sample bivariate correlations indicated that BMI had a positive association with controlling regulations, and a negative association with more self-determined regulations. Given that SDT postulates that controlling regulations are associated with decreased behavior adherence[3], the link between controlling regulations for exercise and higher BMI is intuitive. It is reasonable to ascertain that individuals with a high BMI could view exercise more in terms of losing weight and health consequences then pure enjoyment, subsequently endorsing more controlling regulations for exercise. Previous research has suggested that such body related motives tend not to be sufficient to maintain long-term exercise adherence[4]. A second possible explanation could be that CRCs with high BMI exhibit more controlling regulations because they feel pressured to exercise because of their illness; they feel heath pressure to exercise. There is preliminary indications that lack of health pressure to exercise can contribute to intrinsic motivation[44, 65, 66].

In the present study, it happened that higher BMI was negatively associated with needs satisfaction for competence in an exercise setting. This too is not surprising based on past research indicating that BMI has been negatively related to self-efficacy[99]. It is possible that individuals who are overweight or obese could feel less confident and able to exercise regularly, which in turn could precipitate more controlling behavioral regulations. Body mass index also had a negative relationship with perceived autonomy support. Previous research has associated PAS with greater adherence to clinical exercise and nutrition programs[68, 70]. The negative association between PAS and BMI in this group could also underpin the association between controlling regulations and higher BMI.

One common theme amongst the general medical characteristics of this sample was that higher disability index score, chronic illness score, and BMI were all significantly negatively associated with PNSE for competence. This indicates that individuals who are suffering from concomitant chronic conditions do not feel very capable of exercising, or confident performing exercises that are challenging. Ryan and Deci [96] state that illness often presents functional limitations, which can detract from opportunities for positive experience and well-being. In this case it could be that individuals suffering from chronic illness, disability, or high BMI have functional limitations that reduce their ability, or their perceived ability, to exercise. Interestingly, disability index score was also negatively associated with PNSE for autonomy. It appears that individuals who feel that their activity was limited by a health condition also perceive they have less personal choice and freedom to decide how they exercise. This could have implications for clinical practice for CRCs, such that improving perceptions of needs satisfaction for competence and autonomy could have a significant impact for individuals who suffer from chronic illness or disability. This also indicates that CRCs who have concomitant morbidities or disabilities could benefit from targeted intervention regarding perceptions of needs satisfaction for competence, autonomy, or individualized exercise programming to account for both physical and perceived limitations.

In general, this exploratory analysis suggests that there are some medical characteristics that could negatively impact on behavioral regulation as well as exercise behavior. CRCs who have a high BMI, suffer from chronic illness, or perceive themselves as limited by their health condition have lower levels of exercise and endorse more controlling behavioral regulations. CRCs within these brackets could benefit from targeted interventions aimed at increasing perceptions of needs satisfaction for competence, autonomy, and PAS.

Overall, the practice implications of this research indicate that CRCs should be encouraged integrate their behavioral regulation for exercise. Some possible mechanisms outlined here for facilitating internalization would be to increase satisfaction of the need for competence. This could be accomplished in many ways from counseling to designing introductory exercise sessions to help increase satisfaction of the need for competence. Further to that, increasing perceptions of PAS could prove to be an effective means of improving internalization of exercise behavior.

Strengths and Limitations of the Present Study

There are important strengths and limitations of this study that should be reviewed. A significant strength of this work is that of the patients who were mailed a survey there was an excellent response rate of 60.3%. This is well above the expected response rate, and within range of that seen in previous research with CRCs[17, 30, 38]. This large population-based sample represents one of the largest sample sizes to date in exercise and cancer survivors, and the largest study to date on CRCs and exercise behavior. Such a sample size allows for greater generalizability of this research.

This study also had significant strength in the measurement tools that were employed. Well-developed and reliable SDT measures were used to collect information on behavioral regulation, vitality, and psychological needs satisfaction[48, 74, 100]. The FACT-C represents a widely used and well validated measure of QoL in the cancer domain[13]. A good self-report measure of exercise behavior was also utilized within this study[75, 76]. The strength of these measures also contributes to the generaliziabiltiy of this research.

This research is also strengthened by the use of the well-established theoretical framework of SDT[92]. This research also employed extensive application of theoretical postulates of SDT by examining behavioral regulation in conjunction with psychological needs satisfaction, PAS, and vitality. Further, this was the first known application of SDT to a cancer survivor population, and further extends the exercise and SDT research into a clinical setting. This study was also only the fourth to examine exercise determinants in CRCs. Given the large, and growing number of CRCs in Canada, this work represents an important extension of the literature available on the characteristics of exercise motivation in CRCs.

When interpreting these results, it is important to consider a number of limitations. The primary limitation is the observational design of this study, which limits the ability to draw definitive conclusions of causality from these results. The causal order of motivational characteristics, exercise, QoL, and vitality cannot be determined. Prospective and longitudinal designs are needed to determine the causal effects of behavioral regulation, psychological needs satisfaction, on exercise and QoL in CRCs.

While the response rate of individuals who received the questionnaire was quite good, there is possible two-phase refusal bias evident here. Given that a large number of physicians (524) did not respond to the request to contact, there is possible bias in that the group who was refused was different then the group who was contacted. At this point this bias, and the possible impact on generalizability is unknown.

One important limitation of the study is that selection bias is likely evident here. Given that 40% of the participants did not return the questionnaire, it is possible that individuals interested in exercise would be more likely to complete and return a questionnaire pertaining to exercise. Further to that, permission was not granted to contact 689 potential participants. This limits the genearlizability of these results.

One major limitation of the present study is that all measures of exercise, height and weight were self-reported. Self-reported exercise is a limited marker of exercise in any population. Using quantitative records of physical activity (accelerometer, objective attendance records etc.) would greatly improve the validity of exercise participation information as well as results of the explanatory capability of SDT. Medical data here was also collected via self-report, from which there was a large amount of missing data.

The exercise measure used here assessed past exercise behavior. A prospective measure of exercise would be more powerful. However, previous research demonstrated that past exercise behavior collected in a cross-sectional design was highly correlated with measures of behavior from prospective and longitudinal designs[101]. There was also very little variability in the exercise reported here which likely influences the results of all analysis involving exercise behavior.

All self-determination theory and exercise research to date has been completed on samples of individuals who are currently exercising or involved in sport activities[47-50, 52, 54, 59-65, 74, 83, 100, 102-105]. This study sought to examine the behavioral regulations and psychological needs satisfaction of a diverse group of CRCs, many of whom reported no minutes of exercise per week. Although BREQ-2 has a measure of amotivation and was originally tested in a group from a population of workers, generally, SDT measures are not designed for incorporation in sedentary populations. This could impact the validity of some measures. Further research is needed on the applicability of SDT to populations with more diverse levels of exercise. Additionally, this was the premiere application of SDT measures in a cancer survivor population. Although the results were generally in accordance with SDT, further research is needed within CRCs to fully understand and validate these results.

Finally, results indicate that there is still a significant amount of variance in behavioral regulation, exercise behavior, QoL, and vitality that was not explained by the tenants of SDT. Future research is needed to examine other possible correlates that could further explain the variance in these measures.

Future Research Directions

The research presented here represents the first step in incorporating SDT into the cancer and exercise literature. This study offers preliminary support for the use of SDT in CRCs. However, there are many areas where further research is warranted.

First, there are many improvements in methodology that need to be incorporated for future research. Prospective studies to examine the predictive power of the tenants of SDT on exercise behavior are needed. Use of objective measures for exercise, height, weight, and medical information would also provide more reliable results from which to draw conclusions regarding relationships between SDT and exercise, BMI, and medical profiles. Future research should also attempt to make better use of access to the cancer registry. Improving rates of physician approval could increase the sample size and subsequently the generalizability of this research.

From this research it is clear that there is still a significant amount of variance in exercise behavior that was not accounted for. Future research could improve on this by extending the measures of SDT that were employed here, or even integrating constructs from outside the theory in an attempt to create the most effective model for examining exercise motivation in this population. Integrating concepts such as intention, or further evaluating effects of medical and demographic such as age, sex, BMI, and disability could improve the applicability of SDT to this population.

Future research aimed at further establishing the characteristics of identified motivational regulation for this population is needed. Once the influences of PNSE and PAS (and other possible factors) on identified regulation are better understood, more tailored interventions could be designed to positively impact exercise behavior.

It is clear from the data collected here that exercise participation and adherence is problematic for CRCs. In order to design clinically relevant and effective interventions aimed at curbing this problem well designed intervention research is required. Objective evaluation of the interventions aimed at improving behavioral regulation, psychological needs satisfaction, or PAS have on exercise behavior is warranted. A randomized controlled trial designed to evaluate the effects of interventions such interventions would be ideal.

Further to that, evaluation of concise and practical interventions that are applicable in a cancer care setting would be especially valuable. For example, interventions aimed at efficiently increasing perceptions of autonomy support for exercise from the oncologist/cancer care team. Or development of an 'introduction to exercise for cancer survivors' program aimed at increasing perceptions of needs satisfaction for competence for exercise. Further research aimed at determining which subsets of CRCs would be particularly in need of intervention, or at risk for physical inactivity (eg. high BMI, presence of co-morbidities, endorsement of controlling behavioral regulations) could also help determine which CRCs might most require and benefit from interventions aimed at internalizing behavioral regulations for exercise.

Finally, extension of SDT and exercise research to other important time points for CRCs, like prior to surgery, during treatment, or early in survivorship could also prove to be beneficial. It is also possible that survivors of other cancers such as breast, or prostate cancer would display different motivational characteristics that could warrant investigation using the framework of SDT.

Summary

This study extends the exercise and SDT literature into the cancer survivor population, and premiere application of exercise in cancer survivors for SDT. Overall, support for the applicability of SDT within this population was found. The propositions of SDT as outlined by Deci and Ryan are supported[5], such that more self-determined behavioral regulations were associated with greater levels of exercise, increased PNSE was associated with more self-determined behavioral regulations, and generally, PAS displayed a positive association with behavioral regulation. Further, this study offers some initial support for the incorporation of more clinically meaningful measures of well-being, such as QoL, into SDT and exercise research. While this research is preliminary, it outlines the potential of SDT as a theoretical framework for understanding exercise motivation and behavior in CRCs.

Figure 1. Summary of Participant Eligibility and Response

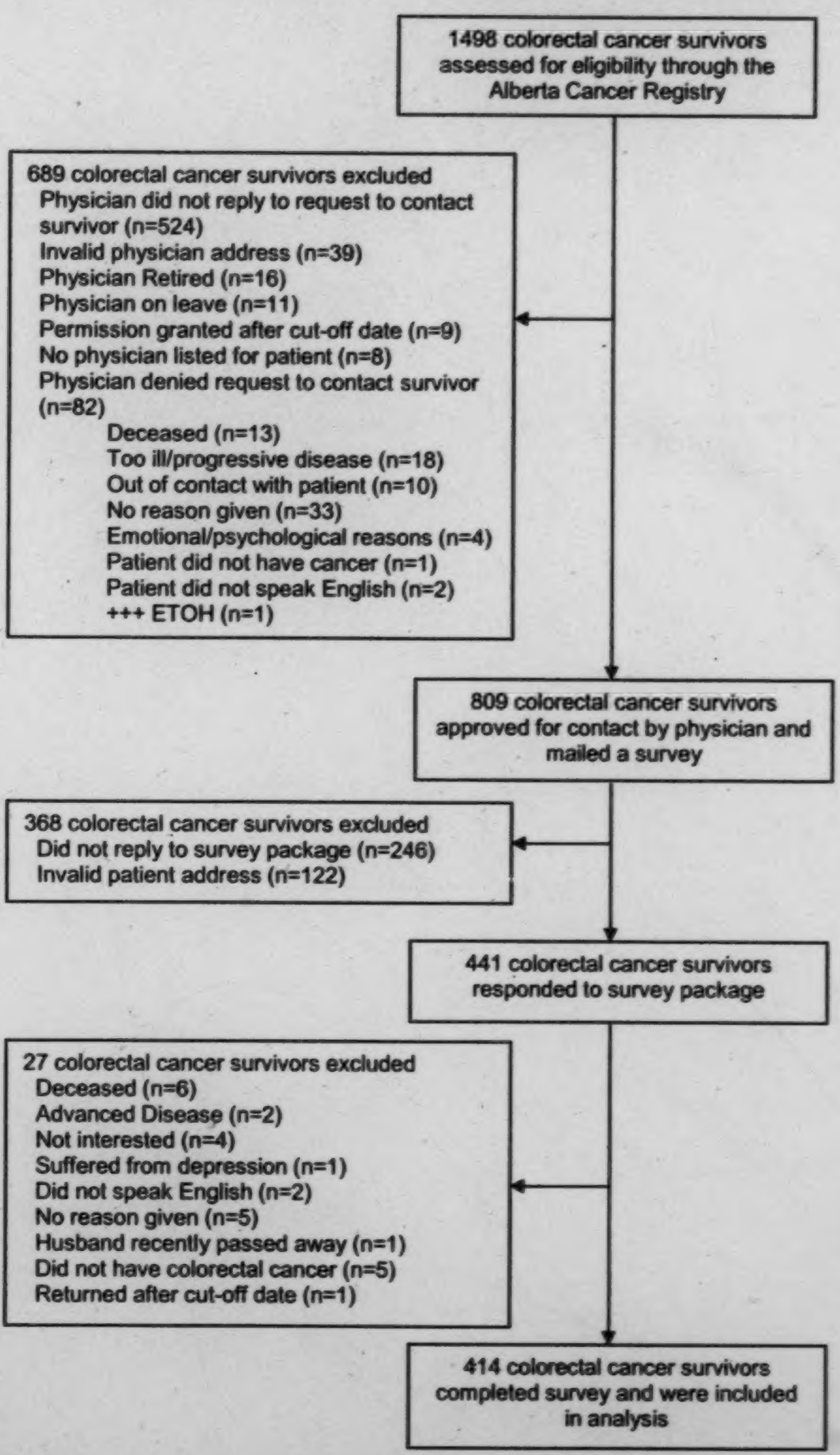

1498 colorectal cancer survivors assessed for eligibility through the Alberta Cancer Registry
689 colorectal cancer survivors excluded
Physician did not reply to request to contact survivor (n=524)
Invalid physician address (n=39)
Physician Retired (n=16)
Physician on leave (n=11)
Permission granted after cut-off date (n=9)
No physician listed for patient (n=8)
Physician denied request to contact survivor (n=82)
Deceased (n=13)
Too ill/progressive disease (n=18)
Out of contact with patient (n=10)
No reason given (n=33)
Emotional/psychological reasons (n=4)
Patient did not have cancer (n=1)
Patient did not speak English (n=2)
+++ ETOH (n=1)
809 colorectal cancer survivors approved for contact by physician and mailed a survey
368 colorectal cancer survivors excluded
Did not reply to survey package (n=246)
Invalid patient address (n=122)
441 colorectal cancer survivors responded to survey package
27 colorectal cancer survivors excluded
Deceased (n=6)
Advanced Disease (n=2)
Not interested (n=4)
Suffered from depression (n=1)
Did not speak English (n=2)
No reason given (n=5)
Husband recently passed away (n=1)
Did not have colorectal cancer (n=5)
Returned after cut-off date (n=1)
414 colorectal cancer survivors completed survey and were included in analysis

Table 1. Demographic Characteristics of Sample

Demographic Variable	n	Mean±SD or %
Age	408	60.2±7.5
< 45	14	3.4
45-54	70	16.9
55-64	184	44.4
65-74	140	33.8
Incomplete	6	1.4
Sex		
Male	224	54.1
Female	186	44.9
Incomplete	3	.7
Marital Status	413	
Married/common Law	335	85.7
Divorced/Separated	30	7.3
Widowed	11	2.7
Never married	17	4.1
Incomplete	1	.2
Education	397	
Some high school	69	16.7
Completed high school	120	29.0
Some university/college	74	17.9
Completed university/college	81	22.0
Some graduate school	23	5.6
Completed graduate school	20	4.8
Incomplete	17	4.1
Annual Family Income	359	
<$20,000	33	8.0
$20,000 - $39,999	105	25.4
$40,000 - $59,000	91	22.0
$60,000 - $79,999	51	12.3
$80,000 - $99,999	32	7.7
>$100,000	47	11
Incomplete	55	13.3
Employment Status	405	
Retired	180	43.5
Disability	29	7.0
Employed full/part time	181	43.8
Temporarily unemployed	15	3.6
Incomplete	9	2.2

Table 2. Medical Characteristics of Sample

Medical Variable	n	Mean±SD or %
Body Mass Index	338	29.0±5.5
<25.0	68	16.4
25.0-29.9	151	36.5
30.0-34.9	75	18.1
35.0-39.9	30	7.2
>40.0	14	3.4
Cancer Site	413	99.8
Colon	318	76.8
Rectal	70	16.9
Colorectal	25	6.0
Disease Stage	396	95.7
I	36	8.7
II	54	13.0
III	82	19.8
IV	26	6.3
Unsure	198	47.8
Surgery for Cancer	411	99.3
Yes	405	97.8
No	6	1.4
Chemotherapy for Cancer	406	98.1
Yes	258	62.3
No	146	35.3
Unsure	2	.5
Physical activity limited by a health condition	405	97.8
No	271	65.5%
Slightly	9	2.2%
A little	22	5.3%
Somewhat	37	8.9%
Quite a lot	53	12.8%
Completely	13	3.1%
Other chronic illness (indicated yes)	406	98.0
Angina	23	5.6%
Heart attack	20	4.8%
Stroke	5	1.2%
High blood cholesterol	145	35.0%
High blood pressure	158	37.9%
Other Cancer	55	13.3%

Table 3. Descriptive Statistics for Exercise Behavior and QoL

Variable	Mean±SD or %
Weekly Exercise Prediagnosis (n= 414)	
Mild Minutes	122.1(243.7)
Moderate Minutes	72.1(155.8)
Strenuous Minutes	35.5(98.3)
Total Minutes	229.7(361.0)
Strenuous plus Moderate Minutes	89.09(125.1)
% meeting ACSM guidelines	24.6%
Weekly Exercise During Treatment (n=414)	
Mild Minutes	81.2(156.5)
Moderate Minutes	29.9(106.3)
Strenuous Minutes	6.9(40.9)
Total Minutes	117.9(224.9)
Strenuous plus Moderate Minutes	36.8(119.5)
% meeting ACSM guidelines	8.7%
Weekly Exercise in the Past Month (n=414)	
Mild Minutes	113.0(219.4)
Moderate Minutes	79.3(178.1)
Strenuous Minutes	26.7(83.5)
Total Minutes	219.0(314.2)
Strenuous plus Moderate Minutes	106.0(211.3)
% meeting ACSM guidelines	25.8%
QoL (n=414)	
FACT-G (0-104)	88.0 (14.2)
FACT-C (0- 180)	148.2(25.1)
Physical Well Being (0-28)	24.3(5.0)
Social Well-Being (0-28)	20.6(4.4)
Functional Well-Being (0-28)	23.2(5.1)
Emotional Well-Being (0-24)	19.9(4.1)

Table 4. Self Determination Variables (n=414)

Variable	Mean±SD or %
Vitality (1-7)	5.16(1.29)
Perceived Autonomy Support	5.27(1.55)
Behavioral Regulation in Exercise Questionnaire	
Amotivation (0-4)	.50(.80)
External Regulation (0-4)	.45(.74)
Introjected Regulation (0-4)	1.08(1.08)
Identified Regulation (0-4)	2.39(1.18)
Intrinsic Regulation (0-4)	2.23(1.30)
Psychological Needs Satisfaction in Exercise Questionnaire	
Relatedness (0-6)	3.86(1.48)
Autonomy (0-6)	5.21(.98)
Competence (0-6)	4.19(1.29)

Table 5. Bivariate correlations between Demographic Variables and Self-Determination Theory Variables

	Age	Sex	Marital Status	Employment Status	Education	Family Income
BREQ-2 Amotivation	.02	-.13**	.04	.03	-.11*	-.03
BREQ-2 External	-.01	-.06	.07	.00	.03	.01
BREQ-2 Introjected	-.04	.09	-.01	-.02	.07	-.01
BREQ-2 Identified	-.01	.05	.02	.03	.18***	.09
BREQ-2 Intrinsic	.01	.06	.09	.02	.14**	.11*
PNSE Competence	.01	-.05	.13**	.13**	.04	.04
PNSE Relatedness	-.01	.10*	.15**	.06	.06	.05
PNSE Autonomy	.00	.07	.09	.11*	.07	.07
Perceived Autonomy Support	.03	.07	.07	-.01	.05	.05
moderate+strenuous minutes of exercise post-treatment	.02	-.01	.01	.05	.16**	.14**

***Correlationis significant at the 0.001 level (2-tailed);** Correlation is significant at the 0.01 level (2-tailed)* Correlation is significant at the 0.05 level (2-tailed).

Table 6. Bivariate correlations between Medical Variables and Self-Determination Theory Variables

	Disability Index	Chronic Illness Scale	Body Mass Index	Type of Cancer	Surgical treatment	Chemo Treatment	Radiation for rectal cancer	Surgery + adjuvant treatment
Amotivation	.05	.09	.15**	-.04	-.04	.01	.04	.02
External	.12*	.05	.21**	-.08	-.04	.04	.05	.04
Introjected	.02	.00	.08	.01	.02	-.03	.01	-.02
Identified	.11*	-.04	-.16**	.03	.00	-.01	.00	.00
Intrinsic	-.09	-.05	-.23***	.05	-.01	.01	-.02	-.01
PNSE Competence	-.31***	-.13**	-.12*	.01	-.03	.03	.02	.03
PNSE Relatedness	-.04	-.07	-.10	-.05	-.03	-.01	.06	.02
PNSE Autonomy	-.22***	-.03	-.08	-.01	-.02	.08	.03	.06
Perceived Autonomy Support	-.07	.01	-.20***	-.05	.04	.01	.07	.05
Exercise Behavior	-.09	-.03	-.13*	.01	.04	-.04	-.02	-.03

***Correlationis significant at the 0.001 level (2-tailed);** Correlation is significant at the 0.01 level (2-tailed)* Correlation is significant at the 0.05 level (2-tailed).

Table 7. Bivariate correlations between amotivation, external, introjected, identified, and intrinsic regulations, and perceived autonomy, and psychological needs satisfaction for competence, relatedness and autonomy.

Variables	1	2	3	4	5	6	7	8
1. Amotivation								
2. External Regulation	.24***							
3. Introjected Regulation	-.21***	.30***						
4. Identified Regulation	-.53***	-.01	.48***					
5. Intrinsic Regulation	-.52***	-.16**	.31***	.77***				
6. Perceived Autonomy Support	-.32***	-.20***	-.10*	.47***	.51***			
7. PNSE Competence	-.30***	-.16**	.04	.45***	.48***	.54***		
8. PNSE Relatedness.	-.24***	-.07	.13**	.38***	.49***	.38***	.54***	
9. PNSE Autonomy	-.26***	-.21***	-.07	.31***	.35***	.41***	.59***	.38***

***Correlation is significant at the 0.001 level (2-tailed);** Correlation is significant at the 0.01 level (2-tailed)* Correlation is significant at the 0.05 level (2-tailed).

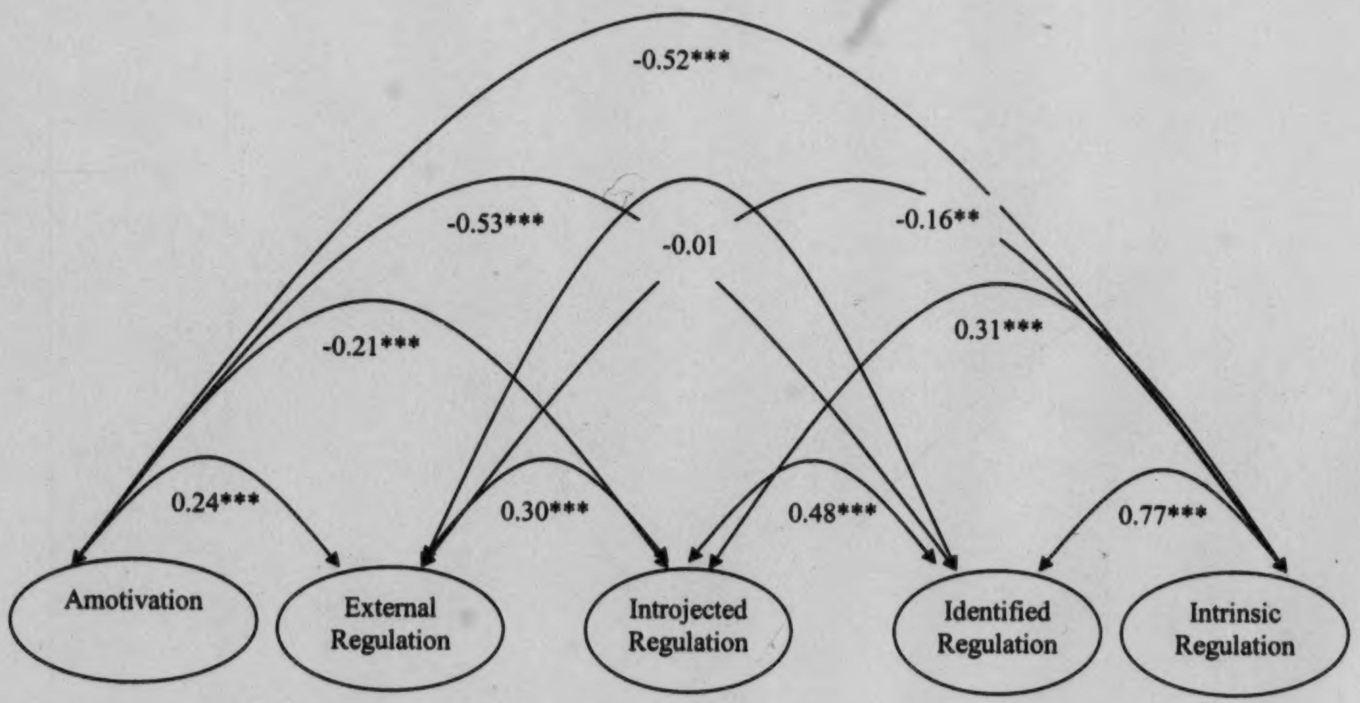

-0.52***
-0.53***
-0.01
-0.16**
-0.21***
0.31***
0.24***
0.30***
0.48***
0.77***
Amotivation
External Regulation
Introjected Regulation
Identified Regulation
Intrinsic Regulation

Figure 2. Interrelationships of BREQ-2 subscales amotivation, external, introjected regulation, identified regulation, and intrinsic regulation
*p<.05; **p<.01; *** p<.001

Table 8. Hierarchical regression of moderate plus strenuous minutes of physical activity on self-determination variables

Steps/predictors	R^2	R^2_{change}	F_{change}	Df	β^1	β^2	β^3
1. Behavioral Regulation	.25	.25	27.61***	5, 408			
Amotivation					-.07	-.07	-.07
External Regulation					-.06	-.05	-.05
Introjected Regulation					.02	.06	.06
Identified Regulation					.31***	.27**	.26**
Intrinsic Regulation					.15*	.06	.06
2. Psychological Needs Satisfaction	.28	.03	5.83**	3, 405			
PNSE Competence						.10	.10
PNSE Relatedness						.12*	.11*
PNSE Autonomy						.05	.05
3. Perceived autonomy support	.28	.00	.03	1, 404			.01

*$p<.05$; **$p<.01$; *** $p<.001$ β^1 = standardized regression coefficienty for equation #1. β^2 = standardized regression coefficients for equation #2. . β^3 = standardized regression coefficients for equation #3. df = degrees of freedom

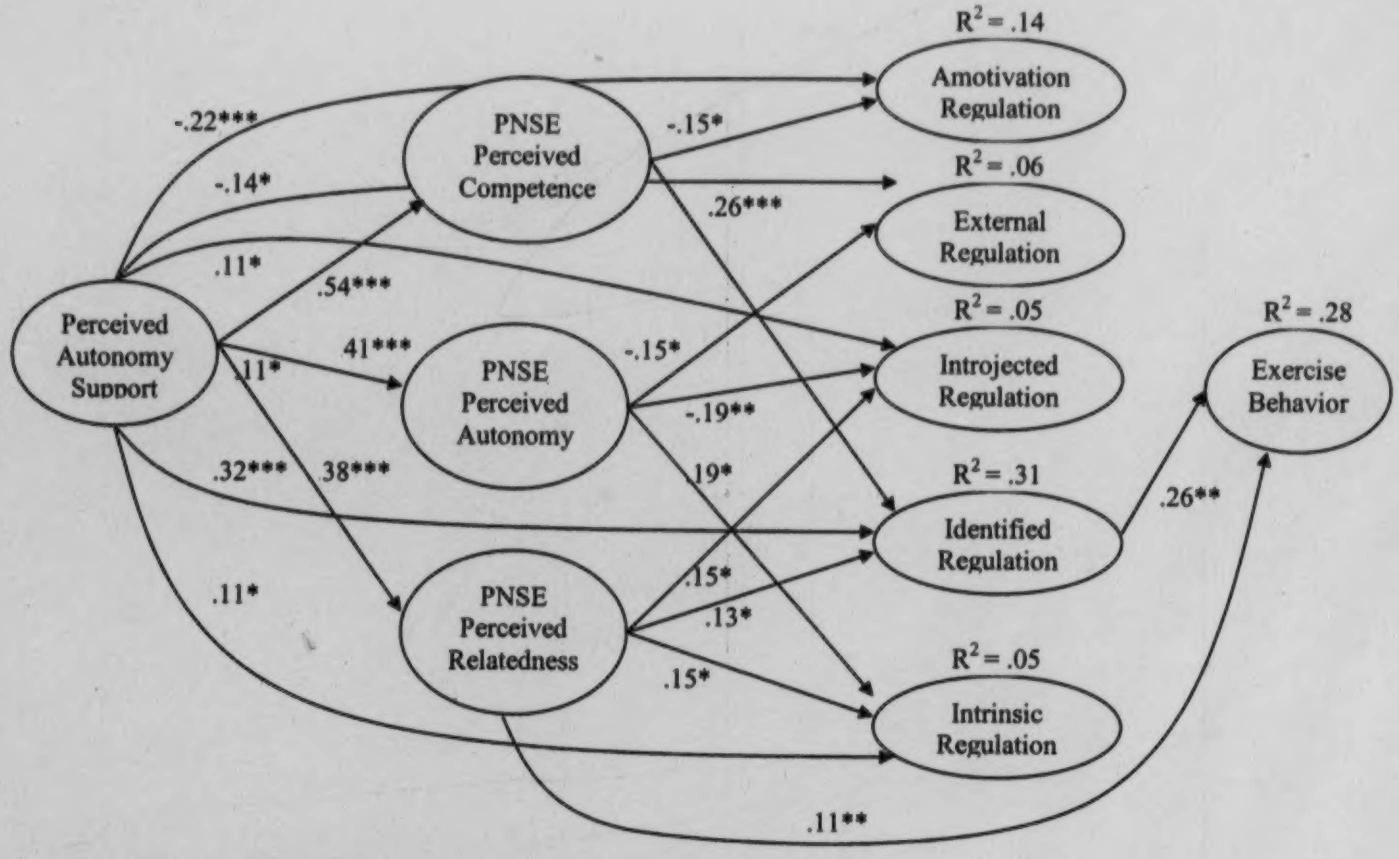

-.22***
-.14*
.11*
.54***
41***
.11*
.32***
38***
.11*
Perceived Autonomy Support
PNSE Perceived Competence
PNSE Perceived Autonomy
PNSE Perceived Relatedness
-.15*
.26***
-.15*
-.19**
.19*
.15*
.13*
.15*
.11**
R^2 = .14
Amotivation Regulation
R^2 = .06
External Regulation
R^2 = .05
Introjected Regulation
R^2 = .31
Identified Regulation
R^2 = .05
Intrinsic Regulation
.26**
R^2 = .28
Exercise Behavior

Figure 3. Path analysis of Self-Determination Theory and Exercise Behavior
*p<.05; **p<.01; *** p<.001
Please note that relationships with p-values ≥ .05 not illustrated here

Table 9. Hierarchical regression of amotivation on psychological needs satisfaction and perceived autonomy support

Steps/predictors	R^2	R^2_{change}	F_{change}	Df	β^1	β^2
1.Psychological Needs Satisfaction	.11	.11	16.15***	3, 410		
PNS Competence					-.18**	-.15*
PNS Relatedness					-.10	-.05
PNS Autonomy					-.11	-.06
2 Perceived autonomy support	.14	.03	16.92***	1, 409		-.22***

*p<.05; **p<.01; *** p<.001 β^1 = standardized regression coefficienty for equation #1. β^2 = standardized regression coefficients for equation #2. . β^3 = standardized regression coefficients for equation #3. df = degrees of freedom

Table 10. Hierarchical regression of external regulation on psychological needs satisfaction and perceived autonomy support

Steps/predictors	R^2	R^2_{change}	F_{change}	Df	β^1	β^2
1.Psychological Needs Satisfaction	.05	.05	6.69***	1, 410		
PNSE Competence					-.07	-.04
PNSE Relatedness					.03	.06
PNSE Autonomy					-.18**	-.15*
2 Perceived autonomy support	.06	.01	6.67*	1, 409		-.14*

*p<.05; **p<.01; *** p<.001 β^1 = standardized regression coefficienty for equation #1. β^2 = standardized regression coefficients for equation #2. . β^3 = standardized regression coefficients for equation #3. df = degrees of freedom

Table 11. Hierarchical regression of introjected regulation on psychological needs satisfaction and perceived autonomy support.

Steps/predictors	R^2	R^2_{change}	F_{change}	Df	β^1	β^2
1.Psychological Needs Satisfaction	.04	.04	5.15**	3, 410		
PNS Competence					.05	.03
PNS Relatedness					.17**	.15*
PNS Autonomy					-.16**	-.19**
2 Perceived autonomy support	.05	.01	3.93	1, 409		.11*

*p<.05; **p<..01; *** p<.001 β^1 = standardized regression coefficienty for equation #1. β^2 = standardized regression coefficients for equation #2. . β^3 = standardized regression coefficients for equation #3. df = degrees of freedom

Table 12. Hierarchical regression of identified regulation on psychological needs satisfaction and perceived autonomy support

Steps/predictors	R^2	R^2_{change}	F_{change}	Df	β^1	β^2
1.Psychological Needs Satisfaction	.23	.23	41.52***	3, 410		
PNS Competence					.31***	.26***
PNS Relatedness					.19***	.13**
PNS Autonomy					.06	-.02
2 Perceived autonomy support	.31	.08	44.55***	1, 409		.32***

*p<.05; **p<..01; *** p<.001 β^1 = standardized regression coefficienty for equation #1. β^2 = standardized regression coefficients for equation #2. . β^3 = standardized regression coefficients for equation #3. df = degrees of freedom

Table 13. Hierarchical regression of intrinsic regulation on psychological needs satisfaction and perceived autonomy support

Steps/predictors	R^2	R^2_{change}	F_{change}	Df	β^1	β^2
1.Psychological Needs Satisfaction	.04	.04	5.15**	3, 410		
PNS Competence					.05	.03
PNS Relatedness					.17**	.15*
PNS Autonomy					-.16**	-.19**
2 Perceived autonomy support	.05	.01	3.93*	1, 409		.11*

*p<.05; **p<..01; *** p<.001 β^1 = standardized regression coefficienty for equation #1. β^2 = standardized regression coefficients for equation #2. . β^3 = standardized regression coefficients for equation #3. df = degrees of freedom

Table 14. Bivariate Correlations Between QoL, Vitality, and Self-Reported Exercise Behavior Within the Past Month

Variable	Mild Minutes	Moderate Minutes	Strenuous Minutes	Moderate + Strenuous Minutes	Total Minutes	Meeting ACSM Guidelines
FACT-C	.13**	.09	.10*	.16**	.17*	.18***
FACT-G	.13**	.07	.09	.13**	.15**	.16*
Physical Well-Being	.08	.10*	.10	.18***	.14**	.18**
Social Well-Being	.15**	.02	.06	.06	.13**	.08
Emotional Well-Being	.05	.03	.02	.06	.05	.08
Functional Well-Being	.12*	.04	.08	.11*	.13**	.14**
Additional Concerns	.11*	.11*	.11*	.17***	.17**	.18***
Vitality	.12*	.12*	.18***	.23***	.20***	.21***

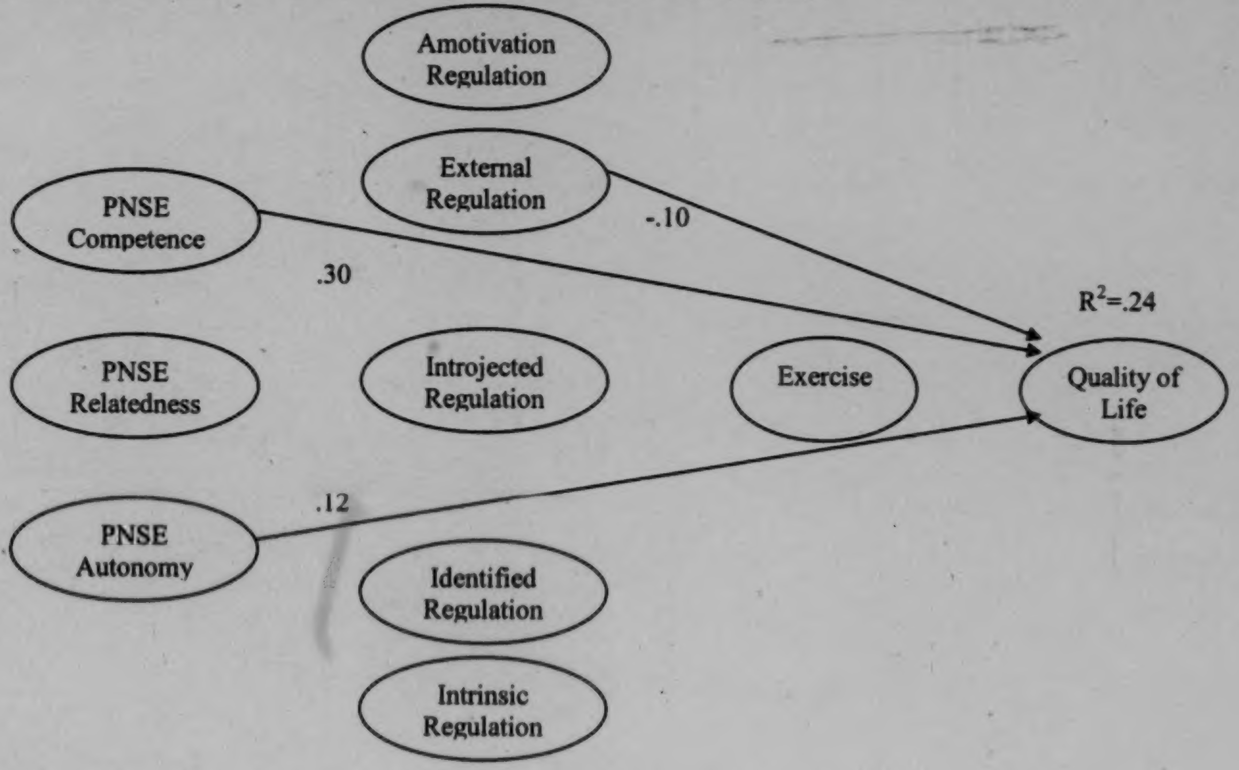
** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed)

Table 15. Hierarchical regression of QoL on exercise, behavioral regulation, and psychological needs satisfaction for exercise

Steps/predictors	R^2	R^2_{change}	F_{change}	Df	β^1	β^2	β^3
1. Exercise Behavior	.03	.03	11.23**	1, 412	.16**	.04	-.02
2. Behavioral Regulation	.15	.12.	11.38***	5, 407			
Amotivation						-.11	-.10
External Regulation						-.12*	-.10*
Introjected Regulation						-.18**	-.09
Identified Regulation						.07	-.05
Intrinsic Regulation						.20*	.12
3. Psychological Needs Satisfaction	.24	.10	16.83***	3, 404			
Competence							.31***
Relatedness							-.04
Autonomy							.12*

*p<.05; **p<.01; *** p<.001 β^1 = standardized regression coefficienty for equation #1. β^2 = standardized regression coefficients for equation #2. . β^3 = standardized regression coefficients for equation #3. df = degrees of freedom

Figure 4. Path analysis of QoL on exercise and amotivation, external, introjected, identified, and intrinsic regulations, and psychological needs satisfaction for competence relatedness and autonomy


Amotivation Regulation
External Regulation
-.10
PNSE Competence
.30
R^2=.24
PNSE Relatedness
Introjected Regulation
Exercise
Quality of Life
.12
PNSE Autonomy
Identified Regulation
Intrinsic Regulation

*p<.05; **p<.01; *** p<.001

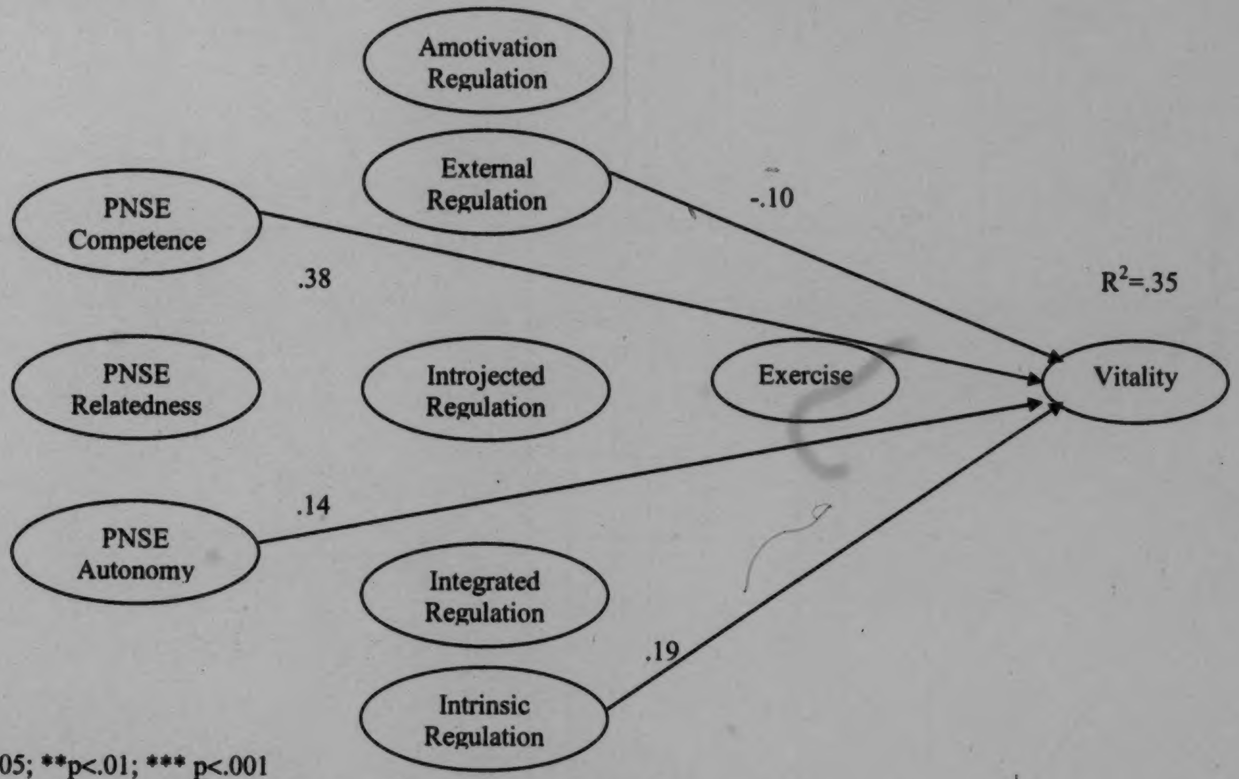
Please note that relationships with p-values ≥ .05 not illustrated here

Table 16. Hierarchical regression of vitality on exercise, behavioral regulation, and psychological needs satisfaction for exercise

Steps/predictors	R^2	R^2_{change}	F_{change}	Df	β^1	β^2	β^3
1. Exercise Behavior	.05	.05	22.98***	1, 412	.23***	.07	-.01
2. Behavioral Regulation	.20	.15	14.83***	4, 507			
Amotivation						.03	.03
External Regulation						-.12*	-.10*
Introjected Regulation						-.17**	-.07
Identified Regulation						.13	-.01
Intrinsic Regulation						.30***	.19**
3. Psychological Needs Satisfaction	.35	.15	32.00***	3, 404			
Competence							.38***
Relatedness							.00
Autonomy							.14**

*$p<.05$; **$p<.01$; *** $p<.001$ β^1 = standardized regression coefficienty for equation #1. β^2 = standardized regression coefficients for equation #2. . β^3 = standardized regression coefficients for equation #3. df = degrees of freedom

Figure 5. Path analysis of vitality on exercise, life on exercise and amotivation, external, introjected, identified, intrinsic regulations, and psychological needs satisfaction for competence relatedness and autonomy


Amotivation Regulation
External Regulation
PNSE Competence
-.10
.38
R²=.35
PNSE Relatedness
Introjected Regulation
Exercise
Vitality
.14
PNSE Autonomy
Integrated Regulation
.19
Intrinsic Regulation

*p<.05; **p<.01; *** p<.001

Please note that relationships with p-values ≥ .05 not illustrated here

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Appendix A. Additional Results

Appendix A. Total of Missing Data From Subscales

Subscale	Number of Missing Data
Physical well-being	0
Social well-being	0
Emotional well-being	2
Functional well-being	2
Additional Concerns	1
Perceived Autonomy Support	18
Vitality	4
BREQ-2 Amotivation	11
BREQ-2 External	6
BREQ-2 Introjected	7
BREQ-2 Identified	7
BREQ-2 Intrinsic	10
PNSE Competence	23
PNSE Relatedness	61
PNSE Autonomy	21

Appendix B. Exercise, Colorectal Cancer and QoL

Colorectal Cancer, Exercise and QoL

Author	Sample	Design	Assessment/Measures	Results
Courneya & Friendenreich, 1997	N=130 • Colorectal cancer survivors • Diagnosed within the previous 4 years and had received adjuvant therapy, and were not currently undergoing treatment	• retrospective	• Exercise behavior prediagnosis, active treatment, posttreatment (GLTEQ) • Current QOL (FACT-C) • SWL (SWL scale Diener et al 1985) • CRC survivors were labeled maintainers, temporary relapsers, permanent relapsers, nonexercisers • Demographic and medical profiles	• Functional QOL was least possessed but most important • Exercise levels decreased from prediagnosis to active Rx, then increased from active treatment to posttreatment, but not back to prediagnosis levels • Permanent relapsers reported the lowest QOL • Cancer treatment has a negative impact on exercise levels and that those previously active individuals who fail to reinitiate exercise after cancer Rx experience lowest QOL 1-4 years later • Functional QOL showed highest correlation with SWL followed by physical QOL • Individuals who were not active before continued to be inactive following diagnosis
Courneya, Friedenreich, Arthus, Bobick, 1999	N=53 • Postsurgical colorectal patients	•	• Assessed exercise at baseline (GLTEQ) • Current QOL (FACT-C) • SWL • Monitored and reported ex over 4-month period, • Then completed another questionnaire • Demographics • BMI • Time since surgery • Tumor site • Pathological disease stage • Surgical procedure • Colostomy presence • Type of adjuvant therapy	• Functional QOL was least possessed but most important dimension underlying overall SWL • Changes in mild exercise from pre-diagnosis to post surgery correlated positively with QOL after 4 month follow up and with changes in QOL from baseline to follow up • Changes in mild exe from prediagnosis to post surgery are positively assoc with QOL in CEC • Decreases in exercise were associated with decreases in QOL vice versa • Likely that QOL in cancer patients ins influenced more by the impact the disease has had on a persons life than by the persons absolute level of functioning following the cancer experience • Mild exercise may be sufficient to improve fitness in cancer patients b/c they tend to be an older, unfit patient population • Also possible that mild exercise may improve QOL through social psychological mechanisms

				that do not require fitness changes o Providing appositive mastery experience, sense of accomplishment, distraction, social interaction
Courneya et al, in press	Exercise • n=69 Control • n=33	• RandomizedTrial • Home based exercise	• Change in QOL o FACT-C • Satisfaction with life (SWLS) • Depression (CES-D) • Anxiety (STAI) • Fatigue (FS) • Cardiovascular fitness o Treadmill test • Body composition o Five site skinfold • Flexibility o Sit and reach • GLTEQ • Demographics • Medical variables • TOI – trial outcome index	• Increased cardiovascular fitness is associated with improvements in QOL in colorectal cancer survivors • Ex group was prescribed a home based personalized exercise program took into account baseline fitness tests o Focus on improving functional well being o Goal was 3-5x/wk for 20-30 min • Control group asked not to begin an exercise program • FACT-C increased in fitness group and decreased in the decreased fitness group • Anxiety • TOI • Borderline in: o SWL, Depression, FACT-G, physical well-being, colorectal cancer subscale • These results suggest that exercise interventions that improved fitness may also enhance QOL in colorectal cancer survivors

Appendix C. Determinants of Exercise in Cancer Survivors

Determinants of Exercise in Cancer Populations

Author	Sample	Design	Assessment/Measures	Results
Young-McCaughan, 1991	71 women treated for breast cancer	Retrospective	- Mailed questionnaire - Cancer history - Activity/exercise report - QOL index for patients with cancer - Perceived Barriers to Exercise Scale	- 42 women who exercised were compared to 29 who did not exercise - No significant differences in demographics or medical characteristics of the groups of exercisers and nonexercisers - Women who exercised perceived significantly fewer barriers to exercise than the nonexercise group - Exercisers were more likely to have participated in high school gym programs and to have been exercising prior to being diagnosed
Leddy, 1997	62 women who were treated for breast cancer within the past ten years	Retrospective	- 16 item incentives and barriers to exercise scale	- Most influential incentives for exercise were expectation of benefit, a sense of responsibility, and previous sport experience - Most influential barriers to exercise were lack of time, inertia, and not in a routine - On average in this group of breast cancer survivors the incentives to exercise slightly outweigh the barriers
Nelson, 1991	55 women who had experienced breast cancer 54 women in a matched cohort who have not experienced breast cancer	Retrospective	- Health Promoting Life-Style Profile - Exercise Benefits/Barriers Scale - Perceived heal	- No significant differences were found for perceived health, self-esteem, and health habits between the cancer survivors and the matched cohort - Significant differences between groups in perceived benefits and barriers to exercise with matched cohort with a higher group mean
Rhodes, 2001	175 non-metastatic breast cancer survivors	Retrospective	- Exercise stage via questionnaire - Personality via NEO-Five Factor Inventory	- Personality discriminates levels of exercise motivation and behavior during and following breast cancer treatment - Personality influences the pattern of exercise across the cancer experience, not just exercise levels at a given time - High levels of neuroticism was found to inhibit regular

				exercise - Extroversion promoted exercise during cancer treatment - Neuroticism was significantly higher for permanent relapsers vs temporary relapsers and maintainers of regular exercise - Nonexercisers had lower scores of extroversion then temporary relapsers - Non-exercisers and permanent relapsers and lower levels of conscientiousness then maintainers and temporary relapsers
Courneya, 2000	37 cancer patients who received high dose chemotherapy and bone marrow transplantation	Prospective	- Background information - Past exercise (GLTEQ) - Intention - Perceived behavioral control (PBC) - Attitude - Subjective norm - Exercise during hospitalization (self-report logs)	- Intention and perceived control explained 36% of the variance in exercise behavior during hospitalization - Perceived control, attitude and subjective norm explained 68% of variance in exercise behavior during hospitalization with PBC making significant unique contributions
Courneya, 1999	164 breast cancer patients	Retrospective	- Background Information - Behavioral Beliefs - Normative Beliefs - Control beliefs - Attitude - Subjective Norm - Perceived behavioral control - Intention - Exercise	- Intention and PBC explained significant variance in exercise behavior - Attitude and subjective norm explained significant variance in intention but perceived control did not add to this variance - Medical variables were not meaningful determinants of exercise during cancer treatment

			behavior (GLTEQ)	
Courneya, 2001	24 breast cancer survivors (members of Dragon Boat Racing Team)	Prospective	- Demographic and medical characteristics - Past exercise (LSI of GLTEQ) - Intention - Perceived Behavioral Control - Attitude - Subjective norm - Behavioral beliefs - Normative beliefs - Control beliefs - Objective measure of attendance at training sessions	- Intention was the sole determinant of exercise adherence explaining 35% of the variance in the program attendance - PBC, SN, explained 49% of the variance in intention both making significant unique contributions - SN was the most important determinant of intention with PBC making smaller contributions
Blanchard, 2002	83 breast and 46 prostate cancer survivors	Retrospective	- Demographic and medical variables - Exercise (LSI of GLTEQ) - Intention - Perceived behavioral control - Attitude - Subjective norm	- Survivors of breast and prostate cancer had similar exercise intentions, attitudes, and subjective norms - For breast cancer survivors attitude, SN, PBC, explained 45% of the variance in intention to exercise with each construct making a significant unique contribution and intention was found to explain 30% of the variance in exercise behavior - Prostate cancer survivors attitude, SN, and PBC explained 36% of the variance in intention. Only PBC made significant unique contribution to intention to exercise and intention was found to explain 36% of the variance in exercise behavior
Courneya, 1997	N=110 Randomly selected	Retrospective Survey	- Exercise during cancer treatment - GLTEQ	- Exercise during treatment was determined by intention and PBC - Intention was determined by attitude

	survivors of colorectal cancer Had undergone adjuvant therapy Age 22-77 63% male 85% disease stage II or III		- Intention - PBC - Attitude - Sub Norms - Salient beliefs - Background information - Demographic variables: age, sex, marital status, education, family income, employment status, height and weigh, BMI - Medical variables, were done as a review of charts and consisted of: months since diagnosis, stage of disease, surgical procedure, type and length of adjuvant therapy	- Different salient beliefs then normal population - Behavioral Beliefs o Get mind off cancer o Feel better and improve well-being o Cope with stress of cancer and treatment o Gain control over cancer and my life o Recover from surgery and treatment - Normative Beliefs o Spouse o Other family members o Friends - Control beliefs o Experienced fatigue/tiredness o No time o Pain or soreness - These were different then a healthy population - Participants engaged in mild exercise about 3x/week, moderate once a week, and virtually no strenuous - No significant differences or relationships in the variables of interest based on demographic or medical variables - Exercise pre-diagnosis had the highest correlation with exercise during treatment - Demographic and medical variables were not meaningful determinants of exercise during cancer treatment - Intention explained significant variance in exercise during treatment - Intention and PBC were direct determinants of exercise during cancer treatment - Attitude explained significant variance in intention
Courneya, 1999	66 Post surgical colorectal cancer patients	Prospective	- Demographic characteristics age, sex, marital status, education, family income, employment status, height and weight	- Cancer treatment has a negative effect on exercise levels - Postsurgical cancer patients reported less strenuous exercise in the 4-month period after surgery than they reported before their diagnosis - Intention explained 26% of variance in exercise behavior with PBC adding 4% - Attitude, PBC and SN explained 23% of the variance in intention to exercise, with attitude making the only

			- BMI - Intention - Exercise (LSI of GLTE)	unique contribution - Three most important normative beliefs were spouse, other family members and physician - Subjective norm not related to intention or behavior - Most important behavioral beliefs were: o Get my mind off cancer and Rx o Maintain a normal lifestyle o Recover from surgery and Rx o Gain control over cancer and my life - Past exercise still an important predictor - Demographic and medical variables were not meaningful determinants of beliefs or exercise behavior
Author	Sample	Design	Assessment/Measures	Results
Pickett, M., 2002	52 newly diagnosed breast cancer patients	Prospective, randomized, controlled, experimental design	- Women were assigned to usual care of home based exercise (walking program) - Daily measure of fatigue, exercise participation, symptoms, side effects in a standardized diary (pre developed and tested) - Activity level rating scale	- About one third of the exercise group did not adhere to a regular exercise program as prescribed here - 22% of exercise group never initiated brisk walking program - 13% stopped th walking program at least 1 month before study conclusion - 52% of the control group engaged in moderate intensity or higher levels of exercise at some point during the study - no clear patters that linked symptoms and side effects to levels of physical activity - majority of women women who met th high activity criteria were able to maintain despite documentation fo symptoms and side effects - recommends theory-based interventions to improve exercise adherence rates for women
Blanchard et al, 2003	352 adult cancer survivors	Retrospective survey	- Demographic and medical variables - Smoking behavior change - Dietary behavior change	- 15.7% adult cancer survivors exercise more following diagnosis - 53.6% exercised the same - 30.6% exercised less - 19% recalled their physician recommending a change in exercise behavior o following analysis, physician influence was

			- Exercise change o One question - Physician recommendation for each behavior	found to be nonsignificant - African Americans, longer term cancer survivors, and those that had completed treatment for more than one year were significantly more likely to increase their exercise behavior after cancer diagnosis than decrease it
Rhodes, 2003	N= 302 203 breast 83 prostate 12 colon 4 lung	Survey	- Regular exercise o Activities performed at least at a moderate intensity 3 or more times per week - Exercise attitude - Subjective norm - Perceived behavioral control - Exercise intention - Exercise behavior o GLTEQ	-
Cooper, 1995 [Cooper, 1995 #83]	n= 75, breast cancer survivors	Survey	- three specific questions regarding physical activity	- women who were more physically active were more likely to report having had more mammograms - reported high levels of physical activity before diagnosis, 71% report involved in PA 3-4 hours/week - women who placed a greater importance on exercise reported exercising more

				- walking/hiking, aerobics, biking most popular forms of PA before and after treatment - number of women who participated in these activities decreased following treatment - number of women who reported no activity before diagnosis (2) increased following diagnosis (10) o mostly attributed to the effects of chemotherapy o tiredness, weakness, worry - 67% reported being able to return to physical activity within three months of treatment o 43% said they faced no obstacles in doing so o most common obstacles were pain, fatigue, embarrassment o those who reported more obstacles also took longer to bevome phyaically active again - most women felt that becoming physically active again was part of the healing process o helped them regain control - nearly 70% of respondents said that they received none or a little info on physical activity from health care providers
Courneya, 2003 [Courneya, 2003 #99]	n=155 Prostate cancer survivors	Randomized controlled trial	- intervention was a resistance exercise training program - medical and lifestyle history - baseline questionnaire (TPB, QOL, - anthropometric measures (height, weight, skinfolds) - muscular strength tests - exercise	- significant relationship found between exercise adherence and: o preprogram overall exercise stage o intention o age o QOL o Fatigue o Subjective norm o Leg press test o Perceived behavioral control o Type of androgen deprivation therapy o Cancer stage (approached significane) - Independent predictors of exercise adherence were: o Preprogram overall exercise stage o Age (age over 75 years negative) o Intention

			behavior prediagnosis, preprogram, program adherence, and nonprogram exercise (LSI of GLTEQ)	- Adherence rate was 78.3% - Found a significant decline in nonprogram aerobic exercise in the exercise group - Minimal contamination it he control group - Patients receiving monotheroay had higher adherence rates than participants receiving combined therapy - Higher disease stage lower adherence
Courneya et al, in press [Courneya, In Press #100]	n=102 69 exercise 33 control	Randomized controlled trial (subsequently collapsed into groups of those who did vs those who did not increase fitness	- TPB - NEO Five Factor Model - Demographic and medical variables -	- 76% adherence, 52% contamination rate - exercise group did not perform significantly more moderate/strenuous exercise - A higher percentage of participants in the exercise group did achieve the minimum exercise prescription of 60 min of mod/stren exercise/week (but not the optimum exercise prescription) - Predictors of contamination o Intention, exercise stage, attitude, and perceived behavioral control o Independent predictors of contamination were intention and exercise stage - Predictors of adherence o Exercise stage, tumor stage, treatment protocol, employment status, chemotherapy, radiotherapy, perceived behavioral control, age, and intention o Independent predictors were exercise stage, employment status, treatment protocol, and perceived behavioral control - Data suggest that contamination problem largely due to participation in action/maintenance stage at baseline - Full-time employment status was a significant negative predictor of exercise adherence.
Courneya, 2002 [Courneya, 2002 #103]	n = 108 mixed cancer survivors	Randomized controlled trial of group psychotherapy classes	- LSI of GLTEQ - TPB - NEO-FFI - Demographic and medical	- Participants in the exercise condition reported signicantly more exercise than those in the control condition o 84.3% participants in ex condition vs 22% in the control group achieved minimum exercise levels - For the entire sample, sig correlation between overall

			variables collected through self-report	RCT exercise and: o past exercise o assignemtn to exp condition o intention o attitude o treadmill time o PBC o Control beliefs - Experimental condition, intention, past exercise, treadmill time, and sex explained 50.6% of the variance - Independent predictors of RCT exercise were: o Past exercise o Experimental condition o Sex o Intention - Predictors of contamination in control group: o Past exercise o Intention o Sex o PBC o Age o Attitude o Treadmill time - Intention, past exercise, treadmill time, and sex predicted 69.5% of variance in contamination - Independent Predictors were: o Past exercise o Intention - Correlates of exercise adherence in the exercise condition o Sex o Past exercise o Neuroticism o Intention o PBC o Treadmill time o Extraversion o Normative beliefs

				o Openness
Pinto et al, 2002[Pinto, 2002 #104]	n = 86 women who have been treated for breast cancer	Prospective survey study	- Paffenbarger Activity Questionnaire - Stages of readiness for exercise adoption - Exercise self-efficacy - Decisional balance - Motivational readiness for weight loss - Dietary behavior questionnaire - Decisional balance for weight loss - Eating slef-efficacy - Belefs about the effects of exercise, dietary change, and future cancer - Reasons for increasing exercise and dietary change	- Only 27% of women met the criteria for regular vigorous exercise - 67% met for moderat intensity exercise - 72% were in action and maintenance stages of exercise adoption - 54% reported engaging in physical activity prior to breast cancer - 24% reported engaging in regulr vigorous exercise - 42% had increased exercise due to breast cancer - 74% believed that exercise could change the course of breast cancer - comparison of 54% overweight or obese, 46% nonoverweight o overweight women reported lower self-efficacy for exercise o endorsed more benefits or pro's with weight loss - The group that reported more healthy behaviors (low fat diet and exercise at recommended levels reported higher efficacy for exercise and healthy eating

Appendix D. Empirical Review Self-Determination Theory and Exercise

Empirical Review of Self-determination Theory in Exercise

Author	Sample	Design	Assessment/Measures	Results
Wilson, PM Rodgers, W.M., in press	• 232 female • mean age 20.86	• Correlational	• BMI • Exercise Levels • Perceived Autonomy Support – Friends (PAS-F) • Behavioral Regulation in Exercise Questionnaire (BREQ-2) • Behavioral Intention	• Correlations indicate the perceived autonomy support from friends was more favorably associated with identified and intrinsic motivation and intention to exercise • Autonomous exercise regulations were more strongly correlated with greater intention to exercise • Tenets of SDT accounted for a substantial portion of the variance in identified and intrinsic exercise regulation and behavior intentions • Identified and intrinsic external regulations are positively associated with future exercise intention and are predicted by greater perceptions of autonomy support from friends
Markland, D, 1999	• 146 females in aerobics	• Cross-sectional • Correlational	• Perceived competence • pcs of intrinsic motivation inventory • Self Determination • locus of causality for exercise scale • Intrinsic Motivation • interest enjoyment scale of intrinsic motivation	• SD moderates the effects of perceived competence on intrinsic motivation • Perceived competence only had an effect on intrinsic motivation when SD was low
Ryan, R.M. et al, 1997	Study 1 • 24 tai kwan doe (tkd)	Study 1 • Prospective	Study 1 • MPAM • Drop out and	Study 1 • Competence and enjoyment motives were predictive of greater adherence and attendance

	(16 men 8 women) - 16 aerobics (all women) Study 2 - N=155 (89 females, 66 males mean age of 19.5 years)	Study 2 - Prospective correlational	attendance variables Study 2 - MPAM - Post-workout ratings	to the chosen activity - Body related motivations (external) were not significantly associated with greater adherence - TKD more highly associated with competence and enjoyment less with body image then participation in aerobics Study 2 - Fitness goals positively correlated with attendance - Body-related motives were not significantly correlated with adherence - Participants with higher enjoyment motives reported longer and more challenging workouts then those lower on these motives - Higher scores on motives led to increased workout enjoyment
Wison, PM, Rodgers, W.M., Fraser, S.N., 2002	**Phase 1** - N=500 - 81.2% female with mean age 28.43 - males mean age 33.63 - predominately students and staff **Phase 2** - N=51 - 76.8%	- Observational	- GLTEQ - BREQ - Psychological needs satisfaction - BREQ - Life Orientation Test (LOT) - Perceived behavioral control	- Perceived competence, relatedness, and autonomy were more positively correlated with identified and intrinsic regulations than with introjected or external regulations - More S-D exercise motives (id, in) exhibited stronger and more positive relations with exercise behavior - Provided support for internal consistency of items comprising BREQ subscales, relation between subscales - Relatedness was the weakest psychological need - Identified regulation appears to be most prominent source of ex motivation assoc with more freq bouts of exercise - Those displaying introjected regulation positively related to strenuous exercise patterns

	female mean age 41.47 • males mean age 42.85 • community members • all enrolled in 12-week supervised exercise program			• Scales demonstrated acceptable levels of internal consistency • Identified regulation was the most strongly endorsed motive for exercise involvement • Partial support for S-D exercise regulations being more positively related to optimism and PBC • Provide further support for psychometric integrity of BREQ as multidimensional measure of ex motivation as well as support of SDT
Biddle, Soos, Chatzisarantis, 1999	• N=723 • school aged childer 12-16 • Country of Hungary	• Observational	• Self-report questionnaire package • TEOSQ (task and ego orientation in sport questionnaire • Perceived competence • Self-regulation scale was modified • Intention	• Participants scored high in intentions and autonomous forms of behave regulation • Task orientation higher than ego • Intention is best predicted by S-D forms of behavioral regulation • Identified forms most correlate with intention • Task orientation had no effect on intention, and can be explained through S-D constructs
Mullen, Markland, and Ingledew	• **Study 1** • N=298 • Sports center attendees • 68% female • 36% university • 52.3% regular exercisers for more then 6	• Observational	• Initial pool of 30 items derived from AMS	• Majority of respondent s found that the amotivation questions were not for them • Discriminate validity was established with reference to subscale inter-correlations • Findings supported the validity of BREQ

	months • **Study 2** • N=310 • equal females and males • 47% exercising regularly • mostly working popln			• Demonstrates the generalizibility of the continuum of behavioral regulation to the exercise domain
Markland and Hardy, 1993	N=400 • all involved in regular physical activity • 249 returned them (65%male)	•	• testing a new measures	• Recreation the most salient reason for exercise in this sample • Analysis offered preliminary support for the EMI scales validity and reliability
Li, Fuzhong	Preliminary studies described to help validate the measure exercise motivation scale N=598	• observational	• Exercise motivation (EMS) • Perceptions of competence • Perceptions of exercise autonomy(modified version of EOLOC) • Relatedness (teacher subscale of the social support scale for children) • Exercise interest (four-item scale drawn from IMI)	• Females reported higher levels of intrinsic motivation and S-D forms of motivation, and were less externally regulated than males • Frequent exercisers showed higher levels of IM to learn and experience sensations, had more integrated and identified regulation • Frequent exercisers more S-D • Provided verification of the continuum • Results showed support for the linearity of the continuum • Does use integration on this scale • Shows applicability in the area of exercise

			• Exercise effort (one question)	
Maltby and Day, 2001	N=556 • 252 men • all undergraduate students • only regular exercisers (exercise 2x / week)	• observational	• asked how many years and months they had been exercising regularly • divided them into those greater and less then 6 months • EMI-2 • General self esteem subscale • **General health questionnaire to measure psychological well-being** • Hassless Scale (stress measure)	• They predict that short-term external exercises motives will be accompanied by poorer psychological well being and vice versa • Those more the 6 months score sig higher on stress mgmt, enjoyment, challenge exercise motive • Those less 6 months sig higher on social recognition, affiliation, and competition exercise motives • Therefore there was a change noticed within this cohort as function of time • Less 6 months scored higher on external exercise motives, somatic symptoms, anxiety, social dysfunction, depression and lower scores on self-esteem • Opposite true for greater 6 months • Overall external exercise motives are correlated with poorer psychological well being and vice versa
Wilson & Rodgers Wilson, 2002	N=114 • Women enrolled in campus rec exercise classes	• Observational • crossectional	• BMI • BREQ • Physical self-esteem (PSE)	• Reported more identified and intrinsic reasons for exercising than external • BMI not associated with either exercise reg or PSE • External regulation was negatively correlated with PSE • Identified and intrinsic reg positively correlated with PSE • Identified and Intrinsic reg predicted PSE group membership (introjected approaching criteria for signif) • BREQ demonstrated an ordered pattern of relationships with one another that was indicative of an underlying continuum of

				psychological need satisfaction
Ingledew, Markland & Medley, 1998	N=425 • British government employees • 3 month followup N=247 • 282 men, 143 women	• Observational • longitudinal	• stages of change question • EMI	Baseline • PC more external • Contemp less so, and the prep – none • Action – more external • Main more intrinsic • Action showed less enjoyment and high appearance/weight mgmt low health pressures Followup • Progress from inactivity to activity assoc with higher level of intrinsic motives Overall • External motives dominate during the early stages of ex adopt • Intrinsic motives important for progression and maintenance • Lack of health pressures contributes to intrinsic motivation
Chatzisarantis, Hagger, Biddle, Karageorghis, 2002	N=140 • 85 males, age 13.53 years	• observational • prospective • crossectional	• PLOC • RAI • PBC • Freq past behave • Intentions • Perceived effort and self-report physical activity (GLTEQ)	• PLOC exerted an indirect relationship with effort and physical activity via attitudes, pbc, and intentions • External reg neg. associated with attitude • Interest and perceived importance of physical activity facilitate deliberation of execution of physical activity • Many small interactions
Frederick & Ryan	N=376 adults • 241 women • Mean age 39 • Employees of e mid-sized university • Men	•	• MPAM • Participation • Multidimensional self-esteem inventory (MSEI) • Center for Epidemiology studies-depression	• Interest/enjoyment and competence motives were higher for sport participants body-related motives were greater for those whose primary activity was of a fitness or exercise variable • Interest/enjoyment positively correlated with number of hours of participation and energy expenditure • Body related motivation was found to correlate

	• Mean age of 41 • Return rate was 10%		inventory (CES-D) • Taylor Manifest anxiety scale (TMAS)	with days per week of exercise and MET score • Fitness group interest/enjoyment correlated positively with primary activity hours, days/week of exercise and energy expenditure • Competence motivation correlated positively with MET score, primary activity hours, days/week of exercise, and energy expenditure • In fitness/exercise participants interest/enjoyment correlated significantly and positively with perceived satisfaction and perceived competence • Competence motivation correlated positively with body functioning self-esteem, perceived satisfaction and perceived competence • However, competence also associated with lower SE and anxiety • MET score correlated positively with body functioning self-esteem and competence • Body related concerns were more salient for women then men • Suggests that a focus upon external attributes such as appearance and body shape rather than task-related attributes is not associated with, and may not be conducive toward, improved mental health

Wang, Chatzisarantis, Spray, Biddle, 2002	N=427
	• 391 girls
	• 11-14 years old
	• Two comprehensive schools in England
		• Cross-sectional cluster analysis	• Sport ability beliefs
			  • CNAAQ-2
			• Perceived locus of causality
			  • PLOC scale
			• Amotivation
			• Physical activity participation
				• Highly, moderately, and lowly motivated youth were found
				• PA sport ability beliefs and SD motivation were highest in the highly motivated cluster
				• High motivation toward PA is characterized by high task and high ego orientation and high perceived competence

Frederick-Recascino, C., Schuster-	• 123 participants • 58	•	• demographic information • MPAM	• Significant overall group diff on dependent variables o interest • Cycling group level of sport competitiveness

Smith, H.[106]????	competitive, amateur bicycle racers reporting an average of 12 hours of exercise/week 19-56 years old - 65 general exercisers undergraduate students in psychology who were members of a college fitness cnter and engage in aerobic and resitance training for 9 hours/week age range of 16-72 mean age 25		- Sport competition trait inventory - Competitive-cooperative attitude scale	positively and sig related to interest/enjoyment motives, appearance motivation, days per week of participation; also general level of competitiveness sig neg correltated with interest/enjoyment motivation - Exercise group sport competition level positively sig correlated with all three types of participation motivation; general competitiveness correlated with days/week of exercise engagement - High sport competitiveness had sig higher interest/enjoyment motivation than those with low sport competitiveness - Those with high sport competitiveness had higher leves of competence motivation than those in low sport competitiveness group
Ingledew, D.K. et al[105]	- 182 individuals in the maintenance stage of exercise - attending a	-	- NEO FFI and EPQ-R for Psychoticism - BREQ - Demographic information	- Those in mainenance higher on extraversion and conscientiousness, lower on external regulation, higher on identified reglation, intrinsic regulation and RAI when compared to those in action - Neuroticims correlated positively with introjected regulation and negatively with RAI

	sports center in England • 90 male • 92 female			• Extraversion corr positively with identified reg and intrinsic reg and RAI • Openness corr negatively with external • Conscientiousness corr negatively with external, positively with intrinsic and positively with RAI • Psychoticims corr positively with external regulation and negativel with RAI • According to RAI those individuals who were less neurotic or more extraverter or more conscientiousness were more likely to be self-determined • Speculate that conscientious individuals possess the "wherewithal" to advance along the continuum of behavioral regulation from external to integrated regulation
Vansteenkiste, M, et al[102]	• N=501 • 232 female • 269 male • 10-12th graders • randomly placed in one of eight conditions	• randomized factorial 4x2 design • future intrinsic goal • future external goal condition • future content free goal • no-future-goal • further was a controlling social condition, as well as autonomy supportive condition	• Perceived autonomy assessed on 5point likert scale from 1(not at all) to 5 very much • BREQ • Effort 7point likert scale ranging from 1(not at all) to 7 (very much) • Graded performance PE teacher graded on quality of student s taiboo performance from 1(very bad) to 10(very good) • Free choice persistnance (asked to give demonstrations to other students at 1	• Participants in the autonomy-supportive condition engaged in a more volitional and willing manner in the activity than those in the controlling conditions • Autonomy-supportive instructions were perceived as granting more autonomy than the controlling instructions • No support for claim that a mere reference to the future yields positive motivational consequences • Future intrinsic goal framing vs. control led to: more effort expenditure than control group, reduced external task regulation, enhanced participants identified regulation and intrinsic regulation, better test performance, ghier persistence at time 2 and 3, more club member ship compared to control. These groups didn't differ in persistence at time 1 • Future external goal vs. no future goal: external goal undermined effor expenditure, increased external regulation, reduced identified regulation and intrinsic regulation, decreased performance,

			week, fourn months) • Sport club membership (member of official taiboo club)	negatively predicted persistence at time 1 compared to control. Persistance at time 2 increased. No difference in time three or club membership • Autonomy supportive vs. controlling: AS more effort expenditure, reduced external and introjected regulation, predicted identified intrinsic regulation, higher performance scores, more activity persisntace at time 1, 2, and 3, as well as more club membership. • Persisntace behaviora was positively correlated with self-reported autonomous motivation when referring to a future intrinsic goal

Appendix E. Questionnaire

Exercise in Colorectal Cancer Survivors

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Instructions*

Thank-you for agreeing to participate in this study. In this questionnaire, we are going to ask you a series of questions about yourself. There are no right or wrong answers and all we ask is that you provide responses that are as honest and accurate as possible. The questionnaire should take about 20-30 minutes to complete. All responses are completely confidential and will never be used in any way that could link them to you. It is important to try and complete all questions but feel free to leave any blank that you choose.

For further information or if you have any questions about completing the questionnaire, please contact Carolyn Peddle (Project

Below is a list of statements that other people with cancer have said are important to their quality of life. Please indicate the extent to which you have experienced each of the statements during the past 7 days whether or not they are associated with symptoms related to cancer by circling the appropriate number using the following scale. It is important that you answer these questions even if it has been many years since your cancer diagnosis. If you do not experience any of the particular symptom please indicate so by circling 0 (not at all).

0	1	2	3	4
not at all	a little bit	somewhat	quite a bit	very much

During the past week:

PHYSICAL WELL-BEING

1. I have a lack of energy	0	1	2	3	4
2. I have nausea	0	1	2	3	4
3. Because of my physical condition, I have trouble meeting the needs of my family	0	1	2	3	4
4. I have pain	0	1	2	3	4
5. I am bothered by side effects of treatment	0	1	2	3	4
6. I feel sick	0	1	2	3	4
7. I am forced to spend time in bed	0	1	2	3	4

SOCIAL/FAMILY WELL-BEING

8. I feel close to my friends	0	1	2	3	4
9. I get emotional support from my family	0	1	2	3	4
10. I get support from my friends	0	1	2	3	4
11. My family has accepted my illness	0	1	2	3	4
12. I am satisfied with family communication about my illness					

	0	1	2	3	4
13. I feel close to my partner (or the person who is my main support)	0	1	2	3	4

0	1	2	3	4
not at all	a little bit	somewhat	quite a bit	very much

During the past week:

EMOTIONAL WELL-BEING

15. I feel sad	0	1	2	3	4
16. I am proud of how I am coping with my illness	0	1	2	3	4
17. I am losing hope in the fight against my illness	0	1	2	3	4
18. I feel nervous	0	1	2	3	4
19. I worry about dying	0	1	2	3	4
20. I worry that my condition will get worse	0	1	2	3	4

FUNCTIONAL WELL-BEING

21. I am able to work (include work at home)	0	1	2	3	4
22. My work is fulfilling (include work at home)	0	1	2	3	4
23. I am able to enjoy life	0	1	2	3	4
24. I have accepted my illness	0	1	2	3	4
25. I am sleeping well	0	1	2	3	4
26. I am enjoying the things I usually do for fun	0	1	2	3	4
27. I am content with the quality of my life right now	0	1	2	3	4

0	1	2	3	4
not at all	a little bit	somewhat	quite a bit	very much

During the past week:

Additional Concerns

28. I have swelling or cramps in my stomach area	0	1	2	3	4
29. I am losing weight	0	1	2	3	4
30. I have control of my bowels	0	1	2	3	4
31. I can digest my food well	0	1	2	3	4
32. I have diarrhea	0	1	2	3	4
33. I have a good appetite	0	1	2	3	4
34. I like the appearance of my body	0	1	2	3	4

Do you have an ostomy appliance?
☐ Yes ☐ No
If yes, please continue.
If no, please skip to question 37.

35. I am embarrassed of my ostomy	0	1	2	3	4
36. Caring for my ostomy appliance is difficult	0	1	2	3	4
37. I feel fatigued	0	1	2	3	4
38. I feel weak all over	0	1	2	3	4
39. I have trouble starting things because I am tired	0	1	2	3	4
40. I have trouble finishing things because I am tired	0	1	2	3	4
41. I have energy	0	1	2	3	4
42. I am able to do my usual activities	0	1	2	3	4
43. I need to sleep during the day	0	1	2	3	4

44. I am too tired to eat	0	1	2	3	4
45. I am frustrated by being too tired to do the things I want to do	0	1	2	3	4
46. I have to limit my social activity because I am tired	0	1	2	3	4

We are interested in the reasons underlying peoples' decisions to engage, or not engage in physical exercise. If you do or do not exercise regularly, using the scale below, please indicate to what extent each of the following items is true for you.

		Not true for me		**Sometimes true for me**		**Very true for me**
1	I exercise because other people say I should	0	1	2	3	4
2	I feel guilty when I don't exercise	0	1	2	3	4
3	I value the benefits of exercise	0	1	2	3	4
4	I exercise because it's fun	0	1	2	3	4
5	I don't see why I should have to exercise	0	1	2	3	4
6	I take part in exercise because my friends/family/partner say I should	0	1	2	3	4
7	I feel ashamed when I miss an exercise session	0	1	2	3	4
8	It's important to me to exercise regularly	0	1	2	3	4
9	I can't see why I should bother exercising	0	1	2	3	4
10	I enjoy my exercise sessions	0	1	2	3	4
11	I exercise because others will not be pleased with me if I don't	0	1	2	3	4
12	I don't see the point in exercising	0	1	2	3	4
13	I feel like a failure when I haven't exercised in a while	0	1	2	3	4
14	I think it is important to make the effort to exercise regularly	0	1	2	3	4
15	I find exercise a pleasurable activity	0	1	2	3	4
16	I feel under pressure from my friends/family to exercise	0	1	2	3	4
17	I get restless if I don't exercise regularly	0	1	2	3	4

18	I get pleasure and satisfaction from participating in exercise	0	1	2	3	4
19	I think exercising is a waste of time	0	1	2	3	4

The following questions are about the people who influence your exercise behavior and decisions. Whether you do or do not exercise regularly, please indicate the degree to which the following statements are true for people who are close to you:

1. People who are close to me understand my exercise decisions
1 2 3 4 5 6 7
not at all true somewhat very true

2. People who are close to me convey confidence in my ability to exercise
1 2 3 4 5 6 7
not at all true somewhat very true

3. People who are close to me accept my exercise decisions
1 2 3 4 5 6 7
not at all true somewhat very true

4. People who are close to me try to understand my exercise decisions
1 2 3 4 5 6 7
not at all true somewhat very true

The following questions contain items that are related to your visits with your doctor. We would like to know more about how you have felt about your encounters with your physician.

1. I feel that my physician has provided me choices and options.
1 2 3 4 5 6 7
strongly disagree neutral strongly agree

2. I feel understood by my physician.
1 2 3 4 5 6 7
strongly disagree neutral strongly agree

3. My physician conveys confidence in my ability to make changes.
1 2 3 4 5 6 7
strongly disagree neutral strongly agree

4. My physician encourages me to ask questions.

1 2 3 4 5 6 7
strongly neutral strongly
disagree agree

5. My physician listens to how I would like to do things.

1 2 3 4 5 6 7
strongly neutral strongly
disagree agree

[illegible]. My physician tries to understand how I see things before suggesting a new way to do things.

1 2 3 4 5 6 7
strongly neutral strongly
disagree agree

The following statements represent different experiences people have when they exercise. Whether you do or do not exercise regularly, please answer the following questions by considering how YOU TYPICALLY feel while you are exercising by circling the appropriate number using the following scale:

1	2	3	4	5	6
False	Mostly False	More False than True	More True than False	Mostly True	True

1. I feel that I am able to complete exercises that are personally challenging	1	2	3	4	5	6
2. I feel attached to my exercise companions because they accept me for who I am	1	2	3	4	5	6
3. I feel like I share a common bond with people who are important to me when we exercise together	1	2	3	4	5	6
4. I feel confident I can do even the most challenging exercises	1	2	3	4	5	6
5. I feel a sense of camaraderie with my exercise companions because we exercise for the same reasons	1	2	3	4	5	6
6. I feel confident in my ability to perform exercises that personally challenge me	1	2	3	4	5	6
7. I feel close to my exercise companions who appreciate how difficult exercise can be	1	2	3	4	5	6
8. I feel free to exercise in my own way	1	2	3	4	5	6
9. I feel free to make my own exercise program decisions	1	2	3	4	5	6
10. I feel capable of completing exercises that are challenging to me	1	2	3	4	5	6
11. I feel like I am in charge of my exercise program decisions	1	2	3	4	5	6
12. I feel like I am capable of doing even the most challenging exercises	1	2	3	4	5	6
13. I feel like I have a say in choosing the	1	2	3	4	5	6

exercises that I do

14. I feel connected to the people who I interact with while we exercise together	1	2	3	4	5	6
15. I feel good about the way I am able to complete challenging exercises	1	2	3	4	5	6
16. I feel like I get along well with other people who I interact with while we exercise together	1	2	3	4	5	6
17. I feel free to choose which exercises I participate in	1	2	3	4	5	6
18. I feel like I am the one who decides what exercises I do	1	2	3	4	5	6

Please respond to each of the following statements by indicating the degree to which the statement is true for you in the past week. Use the following scale:

1. I feel alive and vital.

1	2	3	4	5	6	7
not at all true			somewhat true			very true

2. I don't feel very energetic.

1	2	3	4	5	6	7
not at all true			somewhat true			very true

3. Sometimes I feel so alive I just want to burst.

1	2	3	4	5	6	7
not at all true			somewhat true			very true

4. I have energy and spirit.

1	2	3	4	5	6	7
not at all true			somewhat true			very true

5. I look forward to each new day.

1	2	3	4	5	6	7
not at all true			somewhat true			very true

6. I nearly always feel alert and awake.

1	2	3	4	5	6	7
not at all true			somewhat true			very true

7. I feel energized.

1	2	3	4	5	6	7
not at all true			somewhat true			very true

For these next three questions, we would like you to recall your average weekly exercise during three different time periods in your life: (1) in the **months before your colorectal cancer diagnosis**. (2) during the time **you were receiving treatment for colorectal cancer** , and (3) in the **past month.** Considering a typical week (7 days) how many times on average, did you perform the following kinds of exercise?

When answering these questions please:

- Only count exercise sessions that lasted 10 minutes or longer in duration
- Only count exercise that was done during free time (i.e., not occupation or housework)
- Note that the main difference between the three categories is the intensity of the exercise
- Please write the average frequency on the first line and the average duration on the second
- If you have not performed any exercise in a given intensity, please write 0 in that space

1. Recall your average weekly exercise in the **months before you were diagnosed** with colorectal cancer. Considering a typical week (7 days), how many times, on average, did you perform the following kinds of exercise:

	Times Per Week	Average Duration
a. STRENUOUS EXERCISE (HEART BEATS RAPIDLY, SWEATING) (e.g., running, aerobics classes, cross country skiing, vigorous swimming, vigorous bicycling)	____	_____
b. MODERATE EXERCISE (NOT EXHAUSTING, LIGHT PERSPIRATION) (e.g., fast walking, tennis, easy bicycling,	____	_____

easy swimming, popular and folk dancing)		
c. MILD EXERCISE (MINIMAL EFFORT, NO PERSPIRATION) (e.g., easy walking, yoga, bowling, lawn bowling, shuffleboard, golf)	_____	_____

2. Recall your average weekly exercise **during the time you were receiving treatment** for colorectal cancer (e.g. weeks following surgery, time during radiotherapy or chemotherapy). Considering a typical week (7 days), how many times, on average, did you perform the following kinds of exercise:

	Times Per Week	Average Duration
a. STRENUOUS EXERCISE (HEART BEATS RAPIDLY, SWEATING) (e.g., running, aerobics classes, cross country skiing, vigorous swimming, vigorous bicycling)	_____	_____
b. MODERATE EXERCISE (NOT EXHAUSTING, LIGHT PERSPIRATION) (e.g., fast walking, tennis, easy bicycling, easy swimming, popular and folk dancing)	_____	_____
c. MILD EXERCISE (MINIMAL EFFORT, NO PERSPIRATION) (e.g., easy walking, yoga, bowling, lawn bowling, shuffleboard, golf)	_____	_____

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3. Recall your average weekly exercise **in the past month**. Considering a typical week (7 days), how many times, on average, did you perform the following kinds of exercise:

	Times Per Week	Average Duration
a. STRENUOUS EXERCISE (HEART BEATS RAPIDLY, SWEATING) (e.g., running, aerobics classes, cross country skiing, vigorous swimming, vigorous bicycling)	_____	_____

b. MODERATE EXERCISE
(NOT EXHAUSTING, LIGHT PERSPIRATION)
(e.g., fast walking, tennis, easy bicycling, ____ ____
easy swimming, popular and folk dancing)

c. MILD EXERCISE
(MINIMAL EFFORT, NO PERSPIRATION)
(e.g., easy walking, yoga, bowling, lawn ____ ____
bowling, shuffleboard, golf)

This part of the questionnaire is needed to help understand the characteristics of the people participating in the study. For this reason it is very important information. All information is held in strict confidence.

1. age: _____

2. Sex:

male _____ female _____

3. Marital Status:

never married_____ married_____ common law _____ separated _____

widowed _____ divorced _____

***4.* Education (please check highest level attained):**

some high level	_____	**completed high school**	_____
some university/college	_____	**completed university/college**	_____
some graduate school	_____	**completed graduate school (ie. Masters, Ph.D)**	_____

5. Annual family income:

< 20,000 _____ 20-39,999 _____ 40-59,999 _____

60-79,999 _____ 80-99,999 _____ >100,000 _____

6. Employment status

disability _____ Retired ____ part-time _____

full-time _____ temporarily unemployed _____

7. Height: __________ 8. Weight: _________

9. In the past month, was your participating in physical activities limited by a health condition, injury, or disability?

☐ No ☐ Yes If Yes: How much did this limit you from getting physical activity?

Slightly	***A Little***	***Somewhat***	***Quite a lot***	***Completely***
1	***2***	***3***	***4***	***5***

10. Has a doctor or nurse ever told you that you have had the following

(Please check all that apply):

a. Angina ____ Yes ____ No d. High blood cholesterol ____

Yes ____ No

b. Heart attack ____ Yes ____ No e. High blood pressure

____ Yes ____ No

c. Stroke ____ Yes ____ No f. Other cancer ____ Yes

____ No

This part of the questionnaire is needed to help understand the medical characteristics of the people participating in the study. For this reason it is very important information. All information is held in strict confidence.

What type of cancer were you diagnosed with?

Colon Cancer	**Rectal Cancer**
_____	_____

If you were diagnosed with colon caner please complete section I only. If you were diagnosed with rectal cancer please skip to section II.

Section I – Colon Cancer

1. When were you diagnosed with colon cancer?

Month	**Year**	**Unsure ____**
______	______	

2. What stage of disease were you diagnosed with?

Stage I	**Stage II**	**Stage III**	**Stage IV**	**Unsure**
____	____	____	____	____

3. How far had your cancer grown through the wall of the bowel?

Part of the way through the bowel wall ___ **All of the way through the bowel wall** ___ **Unsure** ____

4. Did your cancer involve the lymph nodes?

Yes ___ **No** ___ **Unsure** ____

5. Did your cancer spread to other parts beyond the bowel and lymph nodes (eg. lung or liver metastasis?)

Yes ___ **No** ___ **Unsure** ____

6. Did your oncologist or doctor ever tell you that your cancer has come back in the same area it was before (a local recurrence)?

Yes ___ **No** ___ **Unsure** ____

7. Did your oncologist or doctor ever tell you that your cancer has come back beyond the same area it was before (a recurrence with metastatic disease)?

Yes ___ **No** ___ **Unsure** ____

8. Did you have surgery to remove the colon cancer?
Yes ___ **No** ___ **Unsure** ____

If yes, please continue. If no, please skip to question 10.

a) When did you have the surgery?

Month ________ **Year** ________ **Unsure** ____

b) Did they remove the entire colon?

Yes ___ **No** ___ **Unsure** ____

9. Did you have chemotherapy treatment following surgery?
Yes ___ **No** ___ **Unsure** ____

If yes, please continue.

a) Did you complete the entire course of chemotherapy?

Yes ___ **No** ___ **Unsure**

____

b) How many treatment cycles did you complete?

Number of Months	**Number of Cycles**	**Unsure**
_____	_______	_______

c) When did you finish you chemotherapy treatment?

Month	**Year**	**Unsure** ____
_______	_______	

Please Turn to the Final Page of the Questionnaire

Section II - Rectal Cancer

1. When were you diagnosed with rectal cancer?

Month	**Year**	**Unsure** ____
_______	_______	

2. What stage of disease were you diagnosed with?

Stage I	**Stage II**	**Stage III**	**Stage IV**	**Unsure**
____	____	____	____	____

3. How far had your cancer grown through the wall of the bowel?

Part of the way **All of the way** **Unsure ____**

through the bowel wall **through the bowel wall ___**

___

4. Did your cancer involve the lymph nodes?

Yes ___ **No ___** **Unsure ____**

5. Did your cancer spread to other parts of your body beyond the bowel and lymph nodes (eg. lung or liver metastasis?)

Yes ___ **No ___** **Unsure ____**

6. Did your oncologist or doctor ever tell you that your cancer has come back in the same area it was before (a local recurrence)?

Yes ___ **No ___** **Unsure ____**

7. Did your oncologist or doctor ever tell you that your cancer has come back beyond the same area it was before (a recurrence with metastatic disease)?

Yes ___ **No ___** **Unsure ____**

8. Did you have surgery to remove the cancer?

Yes ___ **No ___** **Unsure ____**

If yes, please continue. If no, please skip to question 10.

a) When did you have the surgery?

Month **Year** **Unsure ____**

________ ________

b) Did they remove the entire rectum?

Yes ___ **No ___** **Unsure ____**

d) Do you have an ostomy now (a bag attached to an opening on the abdomen to allow feces to exit)?

Yes ___ **No** ___ **Unsure** ____

9. Did you have radiation therapy for your rectal cancer?

Yes ___ **No** ___ **Unsure** ____

If yes, please continue. Otherwise, please skip to question 11.

a) Was your radiation treatment:

Before Surgery ___ **After Surgery** ___ **Both** ____ **Unsure** ____.

b) Did you complete the entire treatment?

Yes ___ **No** ___ **Unsure** ____

c) When did you start your radiation therapy?

Month	**Year**	**Unsure** ____
________	________	

d) When did you finish your radiation therapy?

Month	**Year**	**Unsure** ____
________	________	

10. Did you have chemotherapy treatment for your rectal cancer?

Yes ___ **No** ___ **Unsure** ____

If yes, please continue. If no please turn to the final page of the questionnaire.

a) Was your chemotherapy:

Before Surgery ___ **After Surgery** ___ **Both** ____ **Unsure** ___

b) Did you complete the entire treatment?

Yes ___ **No** ___ **Unsure** ____

c) When did you start your chemotherapy?

Month	**Year**	**Unsure** ____
________	________	

d) When did you finish your chemotherapy?

Month	**Year**	**Unsure** ____
________	________	

Is there anything else you would like to tell us? On this final page, please feel free to make any comments concerning your diagnosis or treatment, the study itself, or exercise. All comments are extremely helpful to us.

Thank you very much for your participation in this research project. Please place the completed questionnaire in the stamped addressed envelope provided.